MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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E. J. STONE, M.A., F.R.S., President, in the Chair.

The Rev. Edward Aurelius Adams, M.A., Vicar of St. John's, Eastbourne;

Major James Fellowes, R.E., Ordnance Survey Office, Southampton; and

Gerard Brown Finch, M.A., 24 Old Buildings, Lincoln's Inn;

were balloted for and duly elected Fellows of the Society.

Note on a Photograph of the Great Nebula in Orion and some new Stars near θ Orionis. By A. Ainslie Common.

The photograph which I have the honour to present to the Society this evening is a carbon enlargement of a negative taken on January 30, 1883, with the three-foot Reflector, the exposure being thirty-seven minutes.

This photograph shows a marked advance on those I have previously shown at meetings of this Society; and although some of the finer details are lost in the enlargement, sufficient remains to show that we are approaching a time when photography will give us the means of recording in its own inimitable way the shape of a nebula and the relative brightness of the different parts, in a better manner than the most careful hand-drawings.

To find if there is any change of form or relative brightness observable in a nebula with any degree of certainty, it will be necessary to compare photographs taken at some undetermined interval of time; and the best thing to do now seems to me to be to get as many photographs as possible, to form the basis of

comparison with those taken at some future time; and this I am now doing.

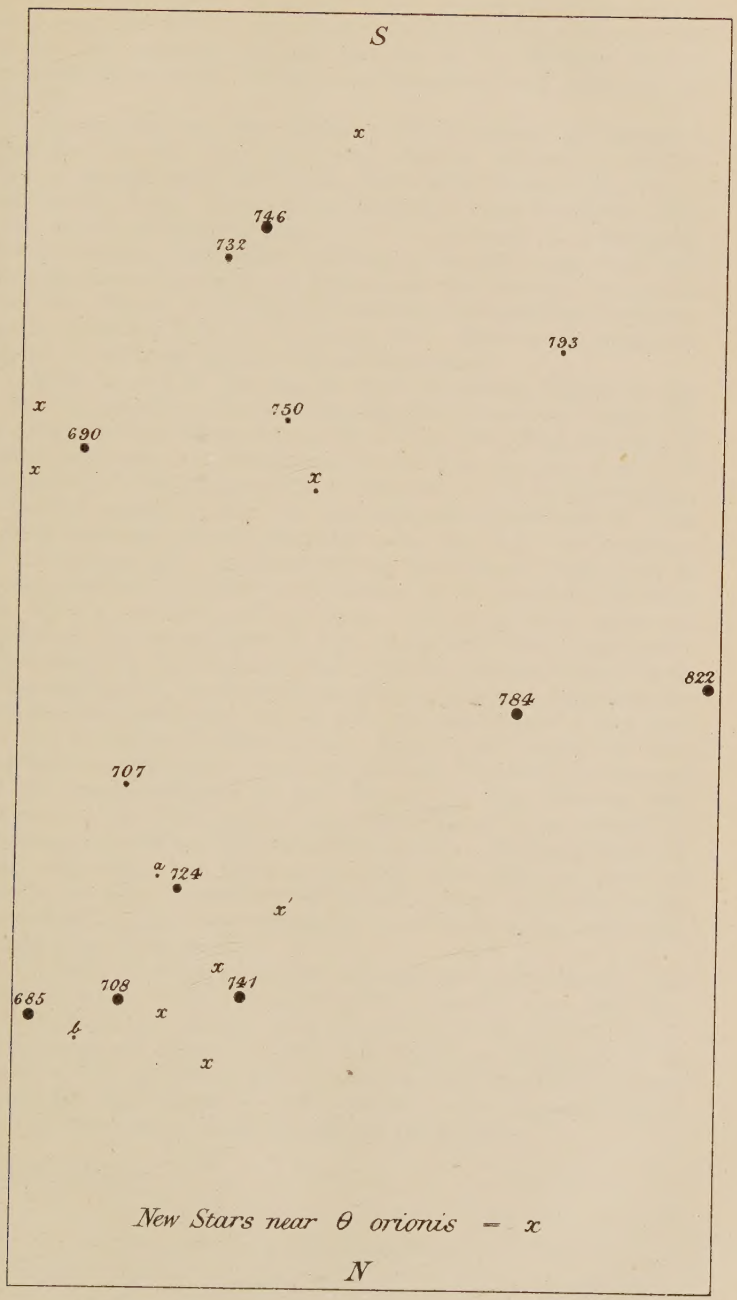
Whilst a comparison of such a photograph as this now shown with any existing drawing can give no reliable evidence of any change having taken place, whatever the observable difference between them may be—for reasons that are very obvious on an inspection and comparison of drawings one with the other—it is very interesting to compare some of the best drawings with the photograph, if only to note the remarkable care that must have been taken in their production.

In making this comparison, the first thing that strikes one is the great difference in the relative intensity of the light of the different parts. This seems to have been the great difficulty always, and from the nature of the object, and the impossibility of having it all in view at once, such a result might be expected. The next thing is the presence of so many long streaks of light of pretty uniform intensity in some drawings, and the general representation of masses of light as rounded or gradually shading off, the photograph showing these as collections of cloudy masses of a knotty or curdled appearance—in this agreeing so well with the eye-view when a powerful telescope is used.

The light of this nebula is so different in intensity that for a proper exposure of the outer portions the central part is much over-exposed; it is therefore necessary to take photographs with different exposures. Thus an exposure of from one to three minutes gives the brighter portions of the central parts in such a way that they can be easily compared and their order noted; longer exposures giving portions less bright in a similar way, till, with a maximum exposure, the very faintest portions can be compared and noted in order. The stars in the nebula can be treated in the same way, the same photographs being available.

This photograph shows some of the fainter portions of the nebula; the most noticeable being (1) the faint crescents of light north of and between the stars 335 and 387 (Bond's numbers are used throughout); these crescents of light, as far as I am aware, are only shown in the beautiful drawing of Lord Rosse, published in the *Philosophical Transactions* for 1868; (2) the dark spaces near and south of the star 479 and the dark space near 570; (3) the peculiar extension of the *proboscis major* at its extremity when it suddenly curves away from the star 793; (4) the nebulous spur (particularly noticed by Sir J. Herschel at the Cape) starting from the star 746 and almost joining the *proboscis major* where it curves away, as already mentioned, as if to make room for it; (5) the large mass of faintish light *p*, the *proboscis major*, and running about parallel with it for some considerable distance from the star 784 up to and beyond the star 793.

There are many other interesting points, about which I hope to have more to say when sufficient materials accumulate for


S
x
746
732
733
x
750
690
x
x
822
784
707
a
724
x'
x
685
708
741
x
4
x
New Stars near θ orionis = x
N

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profitable discussion. It is well known that many of the stars in and about the nebula are variable, particularly the faint ones, but I was not prepared to find that one of the brighter stars is remarkably variable, though what its period is I have not yet found.

On looking over the negatives taken during this winter I find that the star 822, mag. 10·7, was on January 5, according to several negatives taken that night, fainter than 707, a star of 11·2 mag. December photographs show it brighter than 784, and much brighter than 707. On January 13 it was again a little brighter than either; on January 26, 784 (mag. 10·8), and 822 are shown as equal; on subsequent photographs it appears brighter, March 4 photograph showing it much the brightest, quite equalling 724, a 10·5 mag. star. This is the only case noted, it being too apparent to be overlooked.

With regard to the fainter stars, Professor Holden in his "Monograph of the Central Parts of the Nebula in *Orion*," on p. 184, speaking of faint stars, says—"It will be interesting to know if other large telescopes show stars fainter than 675, my 1, 2, 3, or Lassell's *b*." On January 27, it being too windy to photograph, I looked carefully over the sub-nebulous region and at once found three stars surrounding 741—two near 690, one near 750—and one *sp.* 746. A sketch of the positions of these stars is given here, the new stars being marked by an *x* and the old stars by Bond's numbers. These stars have been seen again on February 3, when another, *sf.* 741, was added; this is marked *x'*. On looking on this night at other parts of the nebula other faint stars were found, as might be expected. Amongst these may be mentioned a star in the *nebula oblongata*, about 150″ *p.* 848, and on the *s* border of this *nebula*. This is, no doubt, the star marked *x* in the plate given by Sir John Herschel at the end of the second volume of the *Memoirs* of this Society, and referred to by him in the *Cape Observations*, p. 30, where he expresses himself as satisfied it does not exist. Professor Holden's star 1 was seen, but not 2 or 3, while two stars are noted as visible, *np.* 652. Lassell's *a* and *b* have always been seen easily, as well as 675, the latter appearing to me to be quite outside the bright edge of the *frons*.

Of these faint stars I find on this and other photographs that Lassell's *a* and *b* are shown, as well as the two stars near 690, the star near 750, the star *sp.* 746, and the star *sp.* 741. As these stars appear on negatives taken with exposures of from 37 to 60 minutes, and the time of exposure can be easily extended to hours, it may be, and I think is, quite possible to get stars invisible to the eye in the same telescope used for photography.

1883. *March* 9.

Notes upon certain Doubtful Star-Places. By Professor Truman Henry Safford.

In compiling a star-catalogue which is to possess great precision at the present epoch, it is often found that the proper motion is at fault. So that if we test the position for some past epoch, we find it very accurate; most accurate for the mean epoch according to weights of the original observations; and nearly as precise for the mean epoch according to weights of the modern observations employed: for the best class of compiled catalogues this epoch will be about 1865, or a few years earlier or later.

The difficulty of obtaining precise proper motions is now but small for Bradley's stars, if they were observed four or five times in each coordinate by himself, and is much greater, in Right Ascension at least, for those stars which were first observed by Piazzi, Lalande, or Groombridge, unless, indeed, they happen to be contained in those more precise catalogues which we owe to Struve, Bessel, or Argelander, a few years later.

For Piazzi and Groombridge were in the habit of adjusting their Transit instruments to a mark, and these adjustments were not often enough repeated for security. Moreover, I have noticed with portable instruments that a reaction sometimes takes place after an adjustment, owing perhaps to the state of molecular strain which the movement of a stiff adjusting screw, little used, may cause in the instruments; so that the parts are quite liable to spring some hours after the exact adjustment has been effected. Be this as it may, it is certain that Piazzi's Transit and even Pond's were frequently several seconds of arc out of the meridian; so that it is not to be wondered at if proper motions derived from these astronomers' catalogues are in error.

In volume iv. of the *Annals* of Harvard College Observatory will be found a catalogue of Right Ascensions, including many close polars, which was planned by myself with a view to establishing a standard secondary catalogue for 1865. I have now in hand, with the Repsold Meridian Circle (just commencing its work) of this Observatory, a similar catalogue, a small portion of which has been sent to press; and the intention of the first portion of this catalogue is to enable me to discuss these close polars more fully, in order to get a better basis for the observations in Right Ascension of the early part of this century. Very fortunately there are observations about 1815 by W. Struve, partly reduced, which will enable us to discuss Piazzi's and Groombridge's Right Ascensions with more thoroughness, provided we have good modern determinations for the sake of the proper motions. Of course Auwers's Bradley furnishes us with an admirable series of Right Ascensions for 1755; but many of Groombridge's stars, observed also by Struve, are not contained in that work.

Another aim of my present work is to revise and clear up a good many discrepancies which I have found from time to time in the catalogues. In some cases new observations are needed for this purpose: in many others it seems only necessary to bring together data already accumulated, and show whence discrepancies have arisen.

The set which I shall notice in this paper includes twelve stars from the fundamental catalogue compiled by Professor Auwers in Publication XIV. of the Astronomische Gesellschaft; these twelve are noted by Prof. W. A. Rogers as discordant in Right Ascension from his own observations in a paper contained in vol. x. of the *Memoirs* of the American Academy, pages 389 to 428; this paper will be cited as R., and the fundamental catalogue as A.

The 12 stars are

1. Bradley 6,
2. η Cassiopeiæ,
3. 36 Camelopardi,
4. 1 H. Draconis,
5. Groombridge 2164,
6. θ Draconis,
7. η Draconis,
8. Groombridge 2377,
9. β Lyræ,
10. Groombridge 2900,
11. υ Pegasi,

and the star *b Draconis*; for which Prof. Rogers gives no details in this paper, except on page 412.

By referring to volumes x. and xii. of the Harvard Observatory *Annals*, we find Prof. Auwers has already included all these observations of *b Draconis* in his catalogue; and that the discrepancy did not seem to him to warrant either the exclusion of any observations or any further remark.

Of the remaining eleven stars, Nos. 2, 9, and 11 have been well observed by Bradley, and their proper motions are quite certain. No. 2 is double, and has a pretty large annual proper motion. It was also observed by Prof. Rogers for the most part within about a minute of a preceding star—ζ *Andromedæ*. Under these circumstances there is no great singularity in the difference

$$\overset{s}{A-R} = -0\cdot090 \text{ (12 observations)};$$

especially as the fifteen observations made at Cambridge between 1863 and 1865 give

$$\overset{s}{A-\text{Annals, vol. iv.}} = +0\cdot032,$$

or with systematic correction according to Prof. Rogers

$$\overset{s}{A-\text{Annals, vol. iv.}} = -0\cdot024;$$

whether we consider these discrepancies as due to personal equation, orbital motion, or too great hurry in observation.

Nos. 9 and 11 are discrepant from A. because of errors of computation. The Right Ascensions for 1875·0 in Prof. Rogers's catalogue in volume xii. of the *Annals* should be

h m s
18 45 27·853

and

h m s
23 19 8·520,

instead of $27^{s}\cdot774$ and $8^{s}\cdot400$ respectively; leaving as discrepancies $+0^{s}\cdot007$ and $-0^{s}\cdot024$, instead of $+0^{s}\cdot086$ and $+0^{s}\cdot096$.

None of the remaining eight stars were observed in Right Ascension by Bradley; although four were in Declination. Nos. 5, 8, and 10 have been thoroughly investigated by Argelander, with respect to proper motion; and I see no chance of great error in this element. I have therefore brought up the available newer Right Ascensions of these stars—seconds only—with Argelander's proper motions, as corrected by Auwers for the difference of precession-constants, and with Auwers's or Rogers's systematic corrections, slightly modifying the latter (as I do not understand his Table III. in volume xii. of the *Annals*, and its form is unusual in similar discussions), with the following results, in seconds of time (N. denotes number of observations, W. weight):—

	Gr. 2164.			Gr. 2377.			Gr. 2900.		
	A.	N.	W.	A.	N.	W.	A.	N.	W.
	s			s			s		
Greenwich 1861	16·036	3	1	55·720	5	2	—		
Harv. Coll. 1865	16·129	28	3	—			12·972	10	2
Argelander 1866	—			55·744	8	3	—		
Engelmann 1866	—			55·741	8	3	—		
Pulcova 1871 ...	16·068	—	5	55·724	—	5	12·997	—	5
Greenwich 1872	—			55·705	5	2	12·747	5	2
Harv. Coll. 1872*	16·264	5	2	55·719	5	2	—		
„ 1875†	16·196	5	2	55·637	22	3	13·082	5	2
Mean ...	16·105		11	55·713		18	12·962		11

The final deviations of Harvard College 1875 are respectively

s s s
$-0\cdot091$, $+0\cdot076$, $-0\cdot120$,

instead of

s s s
$A-R=-0\cdot087$, $+0\cdot093$, and $-0\cdot156$.

* From Auwers.

† With Rogers's systematic correction, as given by himself. This number includes the observations of the preceding line, which are omitted in taking the mean.

Neither set of discrepancies seem excessive, considering the Declinations of the three stars

$$59^{\circ}8, \quad 57^{\circ}0, \text{ and } 79^{\circ}4.$$

Of the remaining five stars, four are in Bradley's catalogue, but not observed in Right Ascension. The proper motions of these are given by Prof. Auwers as rather insecure; they are not very important as fundamental stars, and I give simply the corrections which the Right Ascension of A. seems to need, from a rough comparison of the available material.

Bradley 6 ...	...	$+0^{s}\cdot108 + 0^{s}\cdot019 \ (t-1875)$
36 Camelopardi ...		$+0^{s}\cdot050 + 0^{s}\cdot0053 \ (t-1875)$
θ Draconis...	...	$-0^{s}\cdot037 - 0^{s}\cdot0030 \ (t-1875)$
η Draconis	...	$-0^{s}\cdot076 - 0^{s}\cdot0060 \ (t-1875)$

These diminish Prof. Rogers's discrepancies from

$$-0^{s}\cdot170; \quad -0^{s}\cdot100; \quad +0^{s}\cdot093; \quad +0^{s}\cdot141,$$

to

$$-0^{s}\cdot055; \quad -0^{s}\cdot049; \quad +0^{s}\cdot059; \quad +0^{s}\cdot072;$$

leaving nothing greater than $0^{s}\cdot034 \sec\delta$. The largest discrepancy of all, Groombridge 2164, when reduced to the equator is

$$0^{s}\cdot046 \sec\delta.$$

As the probable error of one Right Ascension in the catalogue of volume xii. is given as

$$\pm 0^{s}\cdot013 \sec\delta,$$

there is nothing very remarkable in the amount of the final difference.

The last star, 1 *Draconis* H, is an important polar. Its magnitude is 4·3; it is within 8°·2 of the north pole, and in a region (9^{h}) of A.R. where other good polars are few; but the observations early in this century are not very accordant. The following five values have been assigned to its annual proper motion by as many astronomers; in each case from a full discussion (probably by least squares) of all available material up to about 1860 or later.

Gould ...	...	$-0^{s}\cdot0077$
Safford ...	...	$+0^{s}\cdot005$
Wagner ...	...	$0^{s}\cdot000$
Albrecht ...	...	$-0^{s}\cdot018$
Auwers ...	...	$-0^{s}\cdot0174$

The cause of these differences lies, probably, in the different weights given to Groombridge, and perhaps Piazzi, or the retention or exclusion of one of them. The mean of all these values, $-0^s{\cdot}0076$, agrees nearest with Dr. Gould's, which I shall retain; with this, the following are the Right Ascensions from the authorities of Publication XIV. and some later:—

	A.			N.	W.
	h	m	s		
Pulcova 1846·9 ...	9	19	5·90	49	4
Washington 1863·5 ...			5·80	13	2
Greenwich 1864·2 ...			5·86	6	2
Harvard Coll. 1864·5			6·02	38	3
Pulcova 1865... ...			5·90	—	7
Greenwich 1870·7 ...			5·65	7	2
Harvard Coll. 1872·9			5·95	28	3
Berlin 1874·8 ...			5·99	18	3
Williamstown 1882·8			5·98	7	2
Mean	9	19	$5{\cdot}906 \pm 0^s{\cdot}022$		28

This probable error holds good for 1867; the correction to A. will be—

$$+0^s{\cdot}166 + 0^s{\cdot}0097\,(t-1875).$$

The Williamstown observations were made for the purpose of obtaining the instrumental corrections, and were reduced by neighbouring polars from A.; the instrument was the Repsold Meridian Circle of this Observatory.

It is much to be desired that this star should be pretty thoroughly observed; I have among my note-books a result of observations at Montsouris, which give for 1875

h m s
9 19 5·71 (70 observations),

but have not the original at hand to refer to; including it with a weight=3, we should have as final result for 1875·0

h m s s
9 19 $5{\cdot}887 \pm 0{\cdot}023$.

Williamstown, Mass.:
1883, *Feb.* 21.

On the Relative Motion of the Components of 6 p Eridani.

By A. M. W. Downing, M.A.

In his recently-published *Double-Star Results*, 1871–1881—a valuable contribution to our knowledge of a hitherto too much neglected department of southern astronomy—Mr. Russell has inserted a note on the southern double star 6 or *p Eridani*, to the effect that the hypothesis that the relative motion of the components is rectilinear and not orbital accords better with all the observations made since Herschel's time, and that therefore, if subsequent observations confirm this result, we must conclude that this star is no longer to be reckoned amongst the known binary systems.

As the point thus raised by Mr. Russell is one of considerable interest, I have thought that it would be worth while to discuss analytically all the available observations (including those made at Sydney) of this star, in order to see if it would be possible to decide between the rival hypotheses. And, as Dr. Doberck has published elements of the star in which the Sydney observations have not been included, it will be possible to see what is the effect of the later observations in modifying these elements.

Dr. Doberck's elements are (*Ast. Nach.* No. 2148)—

$$P = 117\,51 \text{ years}$$
$$T = 1817{\cdot}51$$
$$e = 0\,378$$
$$\Omega = 81^{\circ}\,42'$$
$$\lambda = 327\ 15$$
$$\gamma = 44\ 40$$
$$a = 3''{\cdot}82$$

This double star was first measured by Dunlop in 1825, secondly by Herschel in 1835. Mr. Russell states that neither of these observations accord with the hypothesis that the motion is in a straight line, but that Herschel's *angle* is nearly correct, his distance being a little too small. Dunlop's observation does not agree with the place computed from Dr. Doberck's elements for that epoch, and is probably quite inaccurate, I have therefore made no use of it in deducing new elements, but I have not felt at liberty to reject Herschel's observation, especially as the angle only is used in determining all the elements with the exception of the semi-axis major. (It will be seen that Herschel's observed distance has not been used in determining this latter element.) I have accordingly formed the following six normal angles from the observations by combining them in convenient groups (the angles being reckoned from the circle of declination passing through the principal star at the epoch 1870·0).

	Epoch.	Position-Angle.
I.	1835·03	302°·44
II.	1846·12	276·35
III.	1851·83	266·69
IV.	1858·36	257·58
V.	1870·92	242·08
VI.	1878·68	236·38.

It was evident that Dr. Doberck's period would have to be considerably increased to represent these normal places, and it was found by trial that the following values would nearly represent the observed angles—viz. P=235·02 years, T=1810·98, and e=0·4. From these were computed true anomalies corresponding to each epoch, and hence (using Dr. Doberck's values of Ω, λ and γ) the corresponding position-angles were found. Then by varying successively λ and γ each 1° the differential coefficients of θ (position-angle) with respect to each of these elements were determined, $\frac{d\theta}{d\Omega}$ being of course unity; and by comparing the computed and normal position-angles six equations of condition were formed to determine the corrections to Ω, λ and γ. These being solved by the method of least squares, the new values were Ω=47° 22′, λ=330° 22′, and γ=25° 56′. From these new values were then found true anomalies corresponding to each normal epoch; and from these, with values of the eccentricity e=0·4 and e=0·5, two sets of mean anomalies were computed; and from the errors of these a corrected value of e was found by interpolation, and hence corrected values of P and T were deduced. The values of Ω, λ and γ were again corrected in the manner described above; and finally a was found from all the measures of distance (excluding Dunlop's and Herschel's) in combination with the new values of the other elements.

The elements are then as follows—

$$\begin{aligned} \mathrm{P} &= 224{\cdot}57 \text{ years} \\ \mathrm{T} &= 1814{\cdot}43 \\ e &= 0{\cdot}4127 \\ \Omega &= 48^\circ\ 0'\ (1870{\cdot}0) \\ \lambda &= 329\ 52 \\ \gamma &= 26\ 5 \\ a &= 4''{\cdot}75 \end{aligned}$$

As these elements very fairly represent all the measures except Dunlop's angle (as will be seen from the detailed comparison with observation, given below), they were adopted, as being sufficiently accurate for the present purpose.

We have now to proceed on the assumption that the motion

of the *comes* is uniformly in a straight line—of course excluding Dunlop's and Herschel's measures, as they are manifestly inconsistent with this hypothesis.

Using, then, the last five of the normal position-angles given above, with corresponding values of the observed distances, the equation to the "most probable" right line passing through these five points is—

$$4{\cdot}163 = \rho \cos (\theta - 282^\circ\ 1'),$$

and the epoch of nearest approach of the components on the assumption of rectilinear motion being 1842·62, the distance (ρ) and position-angle (θ) at any time t are found from this equation in combination with—

$$0{\cdot}1205\ (1842{\cdot}62 - t) = 4{\cdot}163 \tan (\theta - 282^\circ\ 1').$$

The following table contains the comparison with the individual annual results, the discordances under (I.) being those resulting from the assumption of elliptic motion, and those under (II.) from the assumption of rectilinear motion :—

Epoch.	Observer.	θ_o	$\theta_o - \theta_c$ (I.)	$\theta_o - \theta_c$ (II.)	ρ_o	$\rho_o - \rho_c$ (I.)	$\rho_o - \rho_c$ (II.)
1825·96	Dunlop	343°·1	+9°·8	+35°·5	2″·5	−0″·27	−2″·12
35·03	Herschel	302·3	−0·3	+8·0	3·65	+0·46	−0·61
45·88	Jacob	276·0	−0·8	−0·5	4·16	+0·24	−0·02
46·35	„	276·5	+0·5	+0·5	4·32	+0·36	+0·13
49·82	„	270·0	+0·2	−0·2		—	
50·80	„	268·7	+0·5	+0·1		—	
51·79	„	266·4	−0·1	+0·3	4·30	−0·03	−0·01
52·76	„	264·8	−0·2	−0·8	4·14	−0·25	−0·20
53·96	Powell	263·2	0·0	−0·6		—	
56·09	Jacob	261·1	+0·5	+0·4	4·70	+0·07	+0·23
57·96	„	258·1	+0·3	0·0	4·49	−0·24	−0·07
61·03	Powell	253·4	−0·3	−0·6	4·86	−0·03	+0·14
70·92	Russell	242·1	−1·0	−0·6	5·46	+0·02	+0·08
77·03	Ellery	237·3	0·0	+0·1	5·0	−0·73	−0·88
78·34	Russell	236·7	+0·6	+0·5	6·09	+0·30	+0·10
79·93	Hargrave	237·3	+2·6	+2·4	5·44	−0·40	−0·69
1880·44	Russell	234·7	+0·4	+0·2	6·30	+0·43	+0·13

In this table θ_o and ρ_o are the observed, θ_c and ρ_c the computed, position-angles and distances respectively; the computed position-angles being corrected for the effect of precession. It appears from this comparison that the hypothesis of orbital motion represents the whole series of observations fairly well, whilst that of relative rectilinear motion does not; and that

even confining ourselves to measures made subsequent to Herschel's observation, the discordances from the first assumption are on the whole no larger than those from the second. It would appear from this, therefore, that, as far as can be judged from the observations as yet published, there is not sufficient evidence to justify us in asserting that *p Eridani* is other than a binary star. It is to be hoped that observers in the southern hemisphere will not lose sight of this interesting double star, but will continue to measure it from time to time.

With regard to the proper motions of the components, it appears from a comparison of their places in the Cape Catalogue for 1840 with those in the Cape Catalogue for 1880 that they have a common proper motion of $+0^{s}.03$ in Right Ascension; whilst in North Polar Distance that of the preceding star (the *comes*) is $+0''.07$, and that of the principal star $-0''.08$. These latter values would support the hypothesis of the *comes* moving relatively in a straight line towards the south, but unfortunately the N.P.D. of the following star in the Cape Catalogue for 1840 depends on a single observation, and therefore no reliance can be placed on the proper motion deduced from it.

Blackheath:
1883, *March* 8.

Notes on some of Schjellerup's Identifications of Al-Sufi's Stars.

By J. E. Gore, M.R.I.A.

Some years since M. Schjellerup, the well-known astronomer, published a French translation of two Arabic manuscripts containing a description of the heavens written in the tenth century by the Persian astronomer Al-Sufi. Schjellerup's translation is entitled *Description des Etoiles Fixes, composée au milieu du dixième siècle de notre ère par l'astronome Persan, Abd-al-Rahman Al-Sufi* (St. Pétersbourg, 1874). Schjellerup gives a synopsis of the stars observed by Al-Sufi, identifying Al-Sufi's stars with those at present recognised by Greek and Roman letters, and also giving the magnitude of each star as estimated by Ptolemy, Al-Sufi, and Argelander. I have carefully gone through all Al-Sufi's descriptions of each constellation, comparing his account of the position of each star with the stars as shown in the atlases of Behrmann, Heis and Proctor, and find that in the great majority of cases Schjellerup's identifications are very correct. There are, however, a good many cases in which I cannot agree with Schjellerup with reference to the star described by Al-Sufi. In the Harvard College *Annals*, vol. ix. p. 48, Peirce gives several cases in which he disagrees with Schjellerup, and to these I have added several others. The following are all the cases in which I differ with Schjellerup:—

Hercules.—Two stars mentioned by Al-Sufi amongst the "externes" of this constellation (page 73) as following

θ *Herculis* are not identified by Schjellerup. They seem to me to be 195, or 199 Heis *Draconis* and κ *Lyræ*. This view seems strengthened by the fact that Al-Sufi in his description of the constellation *Lyra* makes no mention of κ *Lyræ*, so that probably he included it in *Hercules*.

Cassiopeia (page 83).—Peirce is quite right about the 9th star, which is evidently ϕ, and not θ, as Schjellerup gives. For the 8th star Schjellerup gives μ. I prefer θ, however, as Al-Sufi's description applies equally well to it, and as it is brighter than μ, it was probably the star observed by Al-Sufi. It seems improbable that of two stars close together (like μ and θ) Al-Sufi should have recorded the fainter star and omitted the brighter.

Equuleus (page 111).—In the synopsis Schjellerup does not attempt to identify the 4 stars described by Al-Sufi in this constellation; but from Al-Sufi's description they are evidently: 1=α; 2=β; 3=γ and 4=δ *Equulei*.

Aries, 5th star.—Al-Sufi's description would seem to apply better to 4 Fl than to ι, as Schjellerup gives. Al-Sufi says (p. 125): "La 5^{e} se trouve au sud de la 1re (γ), qu'elle précède vers l'occident, étant située sur le cou." This applies to 4, but not to ι, which *follows* and not *precedes* γ. This identification would, however, imply an error of about 2° in the longitude of Ptolemy's star, so that probably Schjellerup's identification is correct.

Taurus (p. 132). Schjellerup does not identify the stars Nos. 29, 30, 31 and 32 of Al-Sufi, but it is evident from Al-Sufi's description that they are the four brightest stars in the *Pleiades*, 32 being probably η (*Alcyone*). In fact, Al-Sufi says with reference to these stars:—"Il est vrai que les étoiles des *Pleiades* surpassent bien les quatre mentionnées ci-dessus, mais je me borne à ces mêmes quatre, parce qu'elles sont très près l'une de l'autre et les plus grandes; c'est pourquoi nous les avons mentionnées en négligeant les autres."

I agree with Peirce's remarks about star No. 6 of the "externes."

Al-Sufi describes (p. 134) a star to the south of the 11th star (γ *Tauri*) which Schjellerup does not identify. This star seems to be either 79 (*b*) *Tauri* or 83 *Tauri*. I prefer 79, as it is slightly the brighter. Al-Sufi says: "Ces trois étoiles font une ligne parallèle à la ligne boréale de la figure du *dal* " (γ, δ and ε *Tauri*). This applies exactly to σ, ρ and Fl 79.

Virgo, 18th star.—From Al-Sufi's description, this is very evidently Fl 82 (*m*) *Virginis*, and not Lalande 25396, as given by Schjellerup in his synopsis. Al-Sufi says (p. 160): "La 18^{e} suit la 17^{e} [76 Fl]; c'est la plus boréale des deux qui se trouvent dans le côté postérieur du quadrilatère, et forme avec l'obscure 17^{e} et *al-simāk* [*Spica*] une ligne à peu près droite; entre elle et la 17^{e}, il y a un peu plus d'une coudée. Ptolémée la dit des moindres de la quatrième grandeur, mais en vérité elle est des moindres de la cinquième. Avec la 16^{e} [74 Fl] et *el-*

simâk elle forme un triangle, *al-simâk* étant au sommet; les deux autres à la base, et la 17e dans le côté méridional du triangle. Entre la 16e et la 18e, il y a moins de deux coudées." All this applies very well to 82 (*m*) *Virginis*, but not at all to Lalande 25396.

Schjellerup identifies the fifth star of the "externes" of *Virgo* with Fl 61 *Virginis*, but it seems to me that the stars 55 and 57 *Virginis* (which are close together) suit Al-Sufi's description better, for he says (p. 161): "La 5e est la suivante; c'est une étoile double de la cinquième grandeur." It must be added, however, that this identification is doubtful, as it would imply a large error in latitude in the place of the star as given by Ptolemy.

Scorpio, 14th and 15th stars (p. 172).—Schjellerup does not identify the 15th star, and identifies the 14th with ζ *Scorpii*. From Al-Sufi's description, however, I believe the 15th star to be ζ and the 14th a nebula closely North of ζ, which I have often observed in the Punjab, India, as a hazy star of about magnitude $4\frac{1}{2}$. This nebula is No. 3652 of Sir John Herschel's catalogue of nebulæ in the *Cape Observations*.

Herschel says: "Place of a double star 5 mag., the *p* but one of 7 bright stars in the middle." The positions of Nos. 14 and 15 given by Ptolemy seem to confirm this view, as he makes the stars differ only 10′ in longitude, but the latitudes differ by 50′, No. 14 being the northern of the two; which agrees with Al-Sufi's description. The stars could not be ζ^1 and ζ^2 *Scorpii*, which have exactly the same Southern Declination.

Schjellerup does not identify No. 1 of the "externes" of *Scorpio*, but it is very evidently the star γ *Telescopii*, which Sir J. Herschel says is in the same field with the nebula 557 *Dunlop*. This nebula is not in Heis' Atlas, but it is marked in Proctor's Atlas, and the star γ *Telescopii* is No. 63 of *Scorpio* in the Catalogue of Behrmann's *Atlas des Südlichen Gestirnten Himmels*, where it is rated 3–4 mag. Lacaille rated it 4 mag. It is No. 7449 of the "Catalogue of 9766 Stars." Al-Sufi says: "Ptolémée la dit nébuleuse."

Sagittarius.—14th star.—Schjellerup says *v*, but this seems to be a misprint for *v*.

26th and 27th stars of *Sagittarius*.—Schjellerup identifies these with *m* and *e* of Lacaille. I cannot find what these stars are, but Al-Sufi's 26th star is evidently No. 77 Behrmann *Sagittarius*, and his 27th is ι *Sagittarii* (5–4 mag. Behrmann).

Aquarius (p. 188).—Schjellerup does not identify the 27th and 28th stars, but they seem to be ψ^1 and ψ^2 *Aquarii*. He identifies the 29th star (and I think rightly) with ψ^3 *Aquarii*.

There seems to be something wrong about Al-Sufi's description of the stars 31 and 32 of *Aquarius*. If we assume these stars to be ω^1 and ω^2 *Aquarii*, Al-Sufi's description will not apply, for he says, "La 32e est la suivante et la plus boréale des deux," whereas, the more northern of the two is *preceding*, not

following. Possibly Al-Sufi may have observed the variable star R *Aquarii*, when at its maximum, as it lies about the right distance south of ω.

Orion, 6th star.—κ is a misprint for k (74 Fl), which is evidently referred to by Al-Sufi. The 9th star is f_2 (72 Fl), not f_1; and the 10th star is f_1 (69 Fl), not f_2. For Al-Sufi says: "La 9^e est la suivante des deux petites contiguës au nord de la 7^e (ξ) et la 8^e (ν).

30th star (p. 206). Schjellerup makes this ν, and Peirce says it is e. I cannot agree with either identification. From Al-Sufi's description the star is c (45) *Orionis*, the northern star in the well-known "sword" of *Orion*. Al-Sufi says: "La 30^e est la boréale des trois étoiles rangées et voisines qui se trouvent au-dessous de la 28^e [ζ *Orionis*], qui est la suivante des trois situées dans la ceinture, s'inclinant de plus d'une coudée vers le sud." This clearly indicates c. Al-Sufi's 37th star is e (29 Fl).

Eridanus, 8th star.—Schjellerup makes this o^2, but Peirce says he prefers 98 Heis *Eridani*. As, however, the latter star is only of the sixth magnitude, I am inclined to agree with Schjellerup that Al-Sufi intended o^2. Ptolemy's star was probably 98 Heis.

34th star.—I agree with Peirce that Al-Sufi's description of the position of this star points to θ *Eridani*, and not to α. Still Al-Sufi says distinctly: "Elle est de la première grandeur; c'est celle que l'on marque sur l'astrolabe méridionale et que l'on nomme *âchir al nahr*, La Fin du Fleuve." However, Peirce is probably right.

17th star of *Eridanus*.—Schjellerup makes this Lalande 4969, but this identification seems doubtful, as Baily says in his notes to Ulugh Beigh's Catalogue: "This star, which is also in Ptolemy's catalogue, cannot now be found."

Canis Major.—I agree with Peirce in his identifications of the stars Nos. 5, 6, 7, 8, 9, without the figure.

Argo, 2nd star (p. 224).—This is called ρ in Proctor's Atlas. Heis calls it ι (15 Fl), and Behrmann ρ, but both these latter authorities agree that the star is B.A.C. 2728.

9th star.—This seems to be Fl 1 *Argûs*; σ is a star about 15° further south.

11th star.—This seems to be B.A.C. 2484 (5 mag. Heis and Behrmann).

13th, 14th, 15th, and 16th stars.—I agree with Peirce in his identifications of these stars.

18th and 19th stars.—I fail to identify these stars from Al-Sufi's description, which does not apply to any stars in the vicinity of ζ, which is Al-Sufi's 17th star. Schjellerup makes the 18th α, which must be a misprint for a. He does not identify the 19th star.

19th star. Al-Sufi in his description of the position of the 33rd star (p. 227) says: "La ligne droit menée de celle-là à la

brillante 17e [ζ *Argûs*] passe entre la 18e et la 19e, qui sont les deux obscures situées au-dessous de la brillante 17e." As this remark does not apply to any naked-eye stars in the vicinity of ζ, it would seem possible that Al-Sufi observed two stars which have since disappeared.

The 25th and 26th stars, which Schjellerup does not identify, seem to me to be respectively *a* and *b Velorum* (rated 4–5 by Behrmann). Taking Peirce's identifications of the 23rd and 24th stars as correct (as they seem to be), Al-Sufi's description applies exactly to *a* and *b Velorum*.

With reference to Peirce's remarks about Al-Sufi's stars 28, 29, and 30 of *Argo*, I find that Peirce's stars *a Mali*, *c Mali*, and *d Mali* are identical respectively with o^2, o^3, and o^4 *Navis*, given by Schjellerup; so that Peirce really agrees with Schjellerup.

Hydra, 11th star.—Schjellerup does not identify this star, but from Al-Sufi's description (p. 233) it seems to be 58 Heis *Hydræ* (=3226 B.A.C.). Al-Sufi says: "La 11e est une petite étoile des moindres de la sixième grandeur; Ptolémée la dit absolument de la sixième. Elle se trouve dans le voisinage et du côté boréal de la brillante [*a Hydræ*] située entre celle-ci et la 10e [τ' *Hydræ*]."

9th star.—Schjellerup makes this *a Centauri*, but this is evidently a mistake. From Al-Sufi's description the 9th star is plainly 165 Behrmann *Centaurus* (=4759 B.A.C. = 5911 Lacaille).

10th and 11th stars.—Schjellerup calls these *c* and *b Centauri*. They seem to be respectively 175 and 173 Behrmann (5–4 mag.).

19th star.—Schjellerup identifies this with *o*, and does not attempt to identify the 20th star. From Al-Sufi's description the stars 18, 19, and 20 are probably :—18 = ζ (as Schjellerup gives), 19 = v^2 *Centauri*, and 20 = v^1 *Centauri*. The magnitudes given by Behrmann for these stars agree well with those of Al-Sufi.

21st star.—Schjellerup does not identify this; but from Al-Sufi's description of the position of this and the 22nd star (ξ) there can, I think, be very little doubt that the object referred to by Al-Sufi is the well-known cluster ω *Centauri*. Al-Sufi's words are: "La 21e se trouve devant la brillante 18e [ζ], et est de la cinquième grandeur" [I have seen it in the Punjab like a hazy star of about $4\frac{1}{2}$ mag.]; "elle est située où commence la croupe du cheval et finit le dos humain. Il y a entre elle et la 18e une distance de deux coudées et demie." This exactly describes the position of ω.

28th star of *Centaurus*.—Schjellerup does not identify this, but it seems to be Behrmann's 125 *Centauri* (5–6 mag.) (= 4580 B.A.C.). Al-Sufi's description applies to this star very fairly.

37th star.—Schjellerup makes this θ *Centauri*, but this is apparently a misprint. The star referred to by Al-Sufi is—according to his very clear description—the star marked *o* in Behrmann's

Atlas. It is No. 84 (*Centaurus*) in the Catalogue, where it is rated 4·5 mag., but has no letter attached to it. Al-Sufi's magnitude is also 4·5. Al-Sufi's 6th star is *θ*.

Lupus.—With reference to two stars described by Al-Sufi (p. 246) south of *α Lupi*, and which Al-Sufi says are not mentioned by Ptolemy, Schjellerup remarks in a foot-note, "Probablement a_2 and a_1." I cannot find what stars a_1 and a_2 are, but the stars referred to by Al-Sufi are very evidently *ρ* and *σ Lupi*, rated 5 mag. by Behrmann.

16th and 17th stars.—Schjellerup makes the 16th star λ; but as λ is the 6th star, this cannot be λ. He does not identify the 17th. From what Al-Sufi says, the 16th and 17th stars are very evidently *χ* and *ξ Lupi* (5–6 mag. Behrmann).

18th and 19th stars.—Schjellerup makes the 18th *δ Lupi*; but *δ* is the 3rd star. He does not identify the 19th. These stars seem to be 1 and 2 *Lupi* in Proctor's Atlas (30 and 33 Behrmann, *Lupus*).

Corona Australis, 7th star.—Schjellerup makes this *κ*; but this is evidently wrong. The star is clearly *α*, for Al-Sufi says, "La 7^e se trouve au-dessus et près de la 6^e [*β*] vers le nord."

10th star.—This Schjellerup does not identify, but it is probably 20 Behrmann (= 6444 B.A.C.).

13th star.—Schjellerup calls this *ξ*; but in Behrmann's Southern Atlas there is no star which exactly suits Al-Sufi's description, the nearest being Behrmann's No. 8. But this is only 1° south of *κ*, instead of 3° 30′ ("une coudée et demie") as stated by Al-Sufi.

I will conclude with a remark made by Peirce (Harvard *Annals*, vol. ix. p. 51), and which I fully endorse:—"The work which the learning of M. Schjellerup has brought to light is so important that the smallest errors of details become interesting."

The Variability of β Cygni and 63 Cygni.

By the Rev. T. E. Espin, B.A.

It has doubtless escaped Professor Pritchard that the star *β Cygni* has long been suspected of variation. It will be found entered as a suspected variable in *Chambers' Astronomy*, where the authority for its variation is Klein, and in the catalogue of 343 suspected variable stars published in the *English Mechanic* (communication No. III., June 21, 1882), where the authorities are Klein and Webb. A letter of the Rev. Prebendary Webb in the same periodical calls attention to the loss of light of late in this star. *β Cygni* belongs to a class of variable stars which seem quite distinct from the ordinary variables of Class I. and Class II. (*i.e.* stars with periods of less than 80 days and slight variation, and stars with periods above 130 days and great variation). The variation of *β Cygni* is not large—probably less than a magnitude—while the period is one of several years.

A remarkable instance of this class of variable star is No. 140 of the same catalogue, Flamsteed's 63 *Cygni*, R.A. $21^h\ 2^m$ $+47°\ 10'$. In January 1878 it was about 6·0 magnitude. With the exception of a slight fluctuation or two it increased in light till, in November 1881, its magnitude was 4·7. On May 4, 1882, it was as bright, but on August 8 it seemed to have lost light, and on August 11 it was about 5·0 magnitude. On January 15, 1883, it had fallen to 5·6, since which it has increased in light, and is now (February 14, 1883) about 5·1. The comparison stars are :—

5 Ursæ Minoris	4·5
4 „	5·0
59 Cygni	5·3
53 „	5·7

The period from minimum to minimum is thus about five years, and the observed variation max. 4·7± min. 6·0±. If *β Cygni* be a variable of this class the difference between the Harvard and Oxford photometric measures is at once accounted for. It seems impossible to imagine so great an error as half a magnitude in the measures of the former.

West Kirby, Birkenhead :
1883, *Feb.* 15.

Sur l'observation du Passage de Vénus faite à l'Observatoire de Moncalieri. Par F. Denza.

(*Communicated by the Secretaries.*)

J'ai vu dans les *Monthly Notices* de la Société Royale d'Astronomie que ma courte relation sur les observations du passage de *Vénus* faite dans cet Observatoire de Moncalieri a été prise en considération.

Comme la publication de ma relation subit encore quelque retard, et désirant mettre la Commission en état de mieux apprécier la valeur du temps assigné pour le premier contact extérieur, je crois opportun de vous communiquer la circonstance suivante, qui, à mon avis, est importante, afin de vouloir la transmettre à la Commission. Elle est extraite de la Note que j'ai présentée à l'Académie Royale des Sciences de Milan.

"Pendant que je m'appliquais avec la plus grande tension des yeux, à saisir l'instant du contact extérieur, chose fort difficile dans nos conditions, je vis apparaître, un peu avant l'observation du contact extérieur, à peu près une minute et demie ou deux minutes, sur le fond clair du ciel près du Soleil et un peu plus haut que le point fixé (145° du Nord à l'Est), comme une ombre ou une tache noirâtre, sur laquelle je fixai aussitôt mon regard, et que j'observai jusqu'à ce qu'elle s'approchât du Soleil.

"Quand il me sembla que le contour de cette tache touchait le bord du Soleil, ou, pour mieux dire, qu'à peine elle commençait à s'avancer sur ce dernier, le chronomètre marquait

h m s
2 49 31·0, temps moyen de Rome.

"Ce fut là ce que je considérai comme le premier instant du contact extérieur.

"Craignant une illusion, je continuai à y tenir l'œil fixé, mais au bout de 30 secondes environ, l'entaille devenait distincte et certaine, presque un degré plus au Nord que le point établi pour le contact.

"J'attendis encore un peu; et lorsqu'elle fut devenue nettement appréciable, ayant une largeur d'un peu plus de 2″, je marquai l'heure une seconde fois et j'obtins

h m s
2 50 29·7."

Les temps que je viens d'indiquer sont renfermis dans les limites de quelques secondes, à cause de la refraction et surtout à cause de l'ondulation du contour solaire, produite par l'agitation de l'atmosphère. Pour ces mêmes raisons on eut quelque incertitude pour déterminer l'angle de position correspondant au point du bord du Soleil où le contact devait s'effectuer.

Position géographique de l'Observatoire de Moncalieri.

Latitude Nord	=	44° 59′ 51″·3
Longitude West Rome ...	=	4 46 36·8
		h m s 0 19 7·1

On the Observations of the Transit of Venus, 1882, December 5–6, made at the Lick Observatory, Mount Hamilton, California. By Professor David P. Todd, M.A.

(*Communicated by W. H. M. Christie.*)

I arrived at the Lick Observatory, on the summit of Mount Hamilton, in the evening of November 21. The Horizontal Photoheliograph—the chief instrument of the Observatory to be employed during the Transit—had been, in the main, mounted and got in readiness before my arrival by Mr. Fraser, and a few preliminary photographs had already been taken by Captain Floyd. It remained to complete the unfinished portions of the instrument, to mount and adjust the same, to modify some

details of the instrument which had been constructed wrongly, and to make sure of the convenient and effective working of every part.

Especial attention was given to the accurate determination of the position of the focal plane of the objective, and the method adopted—being nothing short of the critical examination, by many persons independently, of several sets of trial plates exposed at varying distances from the objective—finally indicated the setting of the plate-holder true to the $\frac{1}{8000}$th part of its focal length. Great care was taken to prevent the mishap of fogged plates, from scattered and diffused light falling upon the sensitive film during exposure; likewise to insure the perfect definition of the limbs of the Sun and *Venus*, and to produce an image of the Sun on the photographic plates which should be entirely free from abnormal distortion. The wet process was employed in making all the pictures of the Transit, and the photographic operations were in charge of Mr. Lovell.

The Photoheliograph was mainly constructed by Alvan Clark & Sons, and is essentially like those made for the American Transit of *Venus* Commission. A detailed description of these instruments, with plates, is given in Part I. of the American *Observations of the Transit of Venus of* 1874, by Professor Newcomb. The Lick Photoheliograph, like all the others, has an objective five inches in diameter. Its focal length is almost exactly forty feet, or about $\frac{1}{30}$th part greater than the mean focal length of the eight instruments of the Commission. The diameter of the heliostat mirror—an unsilvered glass disk—is a little greater than seven inches. The objective and the mirror were mounted on two adjacent piers, and the plate-holder on a third pier coming up in the interior of the photographic house. These piers were all set in the meridian of the Transit Instrument, and were laid up of brick, their foundation being in the rock of the mountain summit.

The conditions of weather during the two weeks preceding the day of the Transit were, in general, very favourable for the work of preparation. No snow fell, and on only two days were there any rains—these very slight. Violent winds interfered with our operations on three or four days. The temperature was rarely below 50° and most of the time above 60°. At midnight, November 30, the sky cleared, after three and a half days of continuously cloudy weather. From that time until the afternoon of December 7 we saw no cloud, day nor night, which could interfere in the least with any observation we had to make. Thin cirrus was floating above the summit on the morning of the 2nd, but it had vanished completely within two hours; and on three or four occasions clouds were observed near the horizon, but they never rose. The wind blew in fitful gusts night and day the 3rd and 4th, and the morning of the 5th. But very soon after 12 o'clock that day the winds entirely subsided, and for the next fifty or sixty hours the utmost tranquillity prevailed,

the temperature never falling below 60°, and rising to very near 70° in the shade at noon on the day of the Transit.

The Sun rose about 7 o'clock, December 6, with *Venus* a good way on its disk. The planet was observed by Captain Floyd at intervals throughout the time of the Transit, with the 12-inch Equatorial of the Observatory; and with this instrument he made several drawings, and observed the two contacts at egress. These were observed also by myself with the 4-inch Transit Instrument, mounted on its reversing carriage.

The first photograph of the Transit of *Venus* was taken December 5, $19^h\ 11^m$, local mean time. The exposure was $1\frac{1}{2}^s$ long, and the slit $3^{in}\cdot0$ wide. Only a very faint image came out on the plate. The fourth exposure, somewhat shorter, and with the slit the same width, gave, at $19^h\ 17^m$, a picture sufficiently intense for measurement; but the vertical diameter was about $\frac{1}{18}$th part, or $\frac{1}{4}$ of an inch, shorter than the horizontal one, and the limb was not well defined. Plate No. 13, at $19^h\ 50^m$, slit $1^{in}\cdot0$ in width, and exposure $0^s\cdot4$ long, is the first photograph of real value, though the five immediately preceding it may be worth measuring. The width of the slit was gradually reduced as the altitude of the Sun increased, being successively $0^{in}\cdot75$, $0^{in}\cdot5$, and $\frac{3}{8}$ inch, until at $21^h\ 20^m$ it was set at a width of $0^{in}\cdot25$, and so kept until the end. The exposures were quite uniformly $0^s\cdot25$ in length.

Thirteen reversals of the plumb-line were made during the period of the exposures. The exposing-slide was moved to the east and to the west alternately with each exposure. The temperature of the photographic house—in which there was no fire—was frequently read from a standard thermometer, the range being from $65°\cdot7$ at $19^h\ 51^m$, to $75°\cdot4$ at $23^h\ 38^m$. This latter was the time of the last exposure preceding interior contact at egress. After I had observed this contact optically, the exposures were resumed, and ten additional photographs were made. The total number of plates exposed was 147. Subtracting from this number all those exposed at the beginning of the day, the ten made between the two contacts at egress, a few worthless ones, and all others of doubtful value, the total number of plates available for micrometric measurement cannot fall far short of 125, and may somewhat exceed that number.

Before the plates were finally packed in boxes I made a comparative estimate, based on a somewhat rapid examination, of the value of these photographs of the Transit. Each plate was taken up in order and a mark assigned to it on the scale A, $A-$, $B+$, B, $B-$. The mark A means that the plate was judged to be of the very first quality, and capable of the most accurate measurement. Those marked $A-$ are a shade inferior. Second-grade plates are designated by B; those a shade better, but not so good as $A-$, being marked $B+$; while those not up to the grade B are marked $B-$. A few were judged to be worth only a still lower mark, C. The result was as follows:—

A	71
A−	23
B+	13
B	9
B−	3
C	4
Total	123

After I had satisfied myself that no better place than the Observatory vault could be found for the temporary storage of these plates, they were, in great part, deposited there, together with such portions of the Photoheliograph as have yet to be investigated before the reductions of the photographic measurements can be completed. A few of the plates were brought to San Francisco, and placed in the vaults of the Safe Deposit Company of that city. The original record of the photographs was left in the Observatory vault on the mountain, duplicate and triplicate copies of it having been carefully prepared and brought down for preservation elsewhere.

Lawrence Observatory, Amherst, Mass.:
1883, *Jan.* 24.

Observations of the Transit of Venus, 1882, *Dec.* 6, *made at Mells, Ten Miles South of Bath.* By Maures Horner.

Instruments used:

A five-inch Equatorial Refractor, by Cooke, 1864, with position circle and clockwork.

A spectroscope of two prisms, dispersion about 15°, by Hilger; iridium slit shutting without spring, with milled head graduated to 1-900th of an inch. Prisms set to between C and D.

Sidereal time obtained from *α Cygni* by Troughton and Simms' portable transit instrument in conjunction with a Cooke pendulum-clock shortly after sunset.

The morning of the 6th was not quite without hope, for although the clouds appeared heavy, yet the wind kept nearly due north and the temperature low. At noon signs of a breaking in the sky became visible. All preparations were made, and some glimpses of the Sun obtained. The spectroscope was fixed, and the slit, 1-100th of an inch open, adjusted by means of the position circle tangentially as near to 145° as possible. At 1·30 G.M.T. the chromosphere was fairly well observed. Two small protuberances marked out the field of view; the larger one seemed to have rather a filamentary structure, and the space between appeared uneven, but not very active. At the place

where contact was expected it was difficult to keep the image of the chromosphere steady, nevertheless good views were secured. Clouds again came over a few seconds after two o'clock. Suddenly the sky cleared, and at $18^h\ 53^m\ 19^s{\cdot}5$ M.S.T., at about 144°, between the two protuberances an appearance was observed of two dusky streaks like two faint Sun-spot lines. These were so marked, that after two or three seconds the observer called to his time watcher and took his eye off to look towards the clock, then looking again through the spectroscope he saw the single dark thick band stretching down the spectrum.

When the planet had made some progress on the Sun's limb the spectroscope was removed, and a transit eyepiece, power about 85, on the first surface-reflecting prism was applied.

The boiling of the limb became very violent, and sometimes the dark glass was unnecessary.

The first appearance that attracted notice was a distinct prismatic fringe round the edge of the planet, then projected on the Sun to the extent of about three quarters of its disk. This was seen through clouds without dark glass, time $19^h\ 9^m\ 7^s$ M.S.T. About a minute later, still without a shade, a faint hazy light was seen, which rapidly got more distinct, and appeared to encircle the part of the planet outside the Sun. Almost immediately the Sun shone out very clearly, making a neutral tint necessary, and at that moment the limbs of *Venus* could mentally be completed, and thus completed would appear to touch : time $19^h\ 11^m\ 36^s$ M.S.T. In half a minute more the light outside became exceedingly beautiful, but unfortunately a cloud floated by and contact was *estimated* at $19^h\ 12^m\ 41^s$ M.S.T. When the sky cleared at $19^h\ 13^m\ 19^s$ the observer was much surprised to see the planet not completely clear, and therefore this last time was imagined to be very near the moment of contact, as given on page 4 of the Instructions—viz. "when light is about to glimmer," &c. The times given are local sidereal time.

	m s
Longitude of Observatory from Ordnance Map ...	9 33·6
Latitude „ „ ...	° ′ 51 14

The beautiful hazy light outside the Sun's limb, immediately in the rear of the planet, was of considerable breadth; no bright line ring was noticed, nor was any regular black drop perceived, though any amount of such phenomena might have been manufactured out of the undulating limbs of the Sun and planet, especially if the focus had not been fixed before hand. The planet was carefully examined with all kinds of coloured glass and apertures, but nothing remarkable appeared except a distinct and persistent softening of the darkness towards the centre. One very beautiful display was made by a purple glass, which caused all the edges to glow with pink whilst the disks were blue. The most interesting effect was produced by a power of

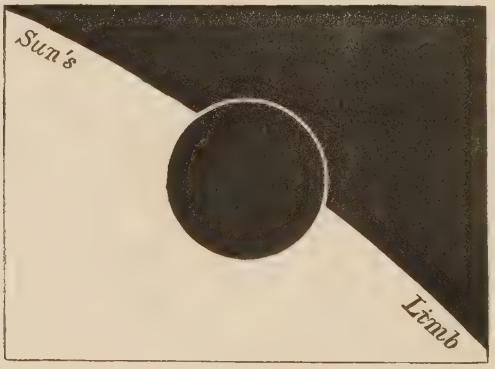
about 30, which gave more perfect idea of the planet's comparative nearness and of its suspension in space than did the higher powers.

The planet's disk was easily seen by the unassisted eye, and indeed without any protection by some young retinas when the Sun was near setting.

The spectroscope observations were made by the Rev. George Horner, and the remainder by the writer of these notes.

Note on the Transit of Venus, 1882, *Dec.* 6. By Charles Leeson Prince.

Since my communication to the Society of Dec. 7, respecting the Transit of *Venus*, I have had the following engraving made of the appearance of the planet's atmosphere shortly before internal contact, which, I trust, will be interesting to those who were not fortunate enough to witness the phenomenon.



The Observatory, Crowborough:
1883, *Feb.* 5.

Notes on the Transit of Venus, 1882, *December* 6. By the Rev. Fred. Howlett.

The drawing of the late Transit—of which I obtained a few brief glimpses between the clouds—as seen projected on a screen in a darkened chamber, is of no really scientific value, but is interesting as showing how very conspicuous the phenomenon appears when observed by the method just mentioned.

Aperture used was 3 inches; focal length 45 inches; power 80.

I first caught a view of the planet at about $2^h\ 5^m$, when it had advanced some 12″ of arc over the Sun's limb. At the moment of first internal contact the Sun was completely clouded, but I obtained a good view of the planet when its following limb at $2^h\ 25^m$ was about 10″ from that of the Sun. At this time *Venus* appeared slightly elliptical in a polar direction, and the "ligament" manifested itself at the time as a dusky, ill-defined, tremulous band intervening between the planet and the Sun's limb. The disk of *Venus* appeared of a very dark Indian-ink brown, and measured upwards of one inch in diameter on the screen. I did not observe any indications of an atmosphere, nor anything of the nature of a central spot of light.

From $2^h\ 26^m$ the Sun was overclouded for the rest of the afternoon.

1882, *Dec.* 8.

Note on Professor Newcomb's Remarks on the Windsor Observations of the Transit of Venus in 1874. By John Tebbutt.

Professor Newcomb, in his remarks (*R. A. S. Notices* for April 1882) on the Instructions of the Paris International Conference for observing the Transit of *Venus* in 1882 states, "that I failed to observe either contact in 1874 through waiting at ingress until almost every vestige of the ligament had disappeared, and at egress by endeavouring to catch its first formation." It is quite possible that Professor Newcomb's statements may to a certain extent be correct, but it is at all events certain that the errors of observation were not great, as the phenomena of the shadowy ligament extended over a very small interval of time. That the errors could not be so great as Professor Newcomb's remarks seem to suggest is conclusively shown by the general result arrived at by Lieut.-Colonel Tupman, in his paper on the Solar Parallax, in the *R. A. S. Notices* for June 1878. The residuals for the Windsor observations of internal contact at ingress and egress, after the rejection of certain observations from other stations, are $12^s{\cdot}1$ and $0^s{\cdot}7$ too late respectively. I do not think, however, that a perfectly satisfactory determination of the value of the Windsor observations can be arrived at till more accurate values are adopted for the longitudes of some of the stations. In the case of Sydney and Windsor I think there can be no doubt that the longitude requires a correction of about four and five seconds of time respectively. The value adopted for Windsor is that contained in the *Nautical Almanac*, which depends on the old and, I believe, erroneous longitude of the Sydney Observatory, combined with the telegraphic difference between the two stations. From a casual consideration of the question it seems probable that had the more correct longitude of Windsor (see *R. A. S.*

Notices, vol. xl. p. 440) been employed, the residuals of that place would have been small and numerically about equal, but affected with different signs, showing that the thread of light was very fine and of nearly the same breadth at both observed internal contacts. In conclusion I may remark that the definition was good at both contacts, and that the contacts themselves were observed under the same conditions as regard aperture and magnifying power.

Windsor, N. S. Wales:
1883, *Jan.* 23.

Observations of the Partial Solar Eclipse, 1882, *November* 10.
By John Tebbutt.

The weather was all that could be desired for the observation of this phenomenon, and the contacts were pretty well observed as follows:—

		d	h	m		
First contact	...	Nov. 10,	19	16	21·2	Local mean time.
Last contact	...	10,	21	47	57·2	

The instrument employed was the $4\frac{1}{2}$-inch Equatorial with the full aperture and a negative eyepiece magnifying 120 diameters, in combination with a diagonal prism and the necessary coloured shade. The instrumental conditions were precisely those under which the last Transit of *Mercury* was observed here. The definition was very fair, and the solar cusps were sharp throughout. The irregularities of the Moon's limb were also well seen, but I could not detect any portion of the limb off the Sun's disk. At $20^h\ 12^m\ 57^s{\cdot}5$ the Moon's limb made first contact with a roundish-black spot, and the last contact at total emersion was observed at $21^h\ 7^m\ 24^s{\cdot}8$. In addition to this isolated spot there was a large group of spots on the Sun's disk, and so conspicuous, indeed, was this group that it could be readily seen with a coloured glass without a telescope. One of the most interesting phenomena in connection with the eclipse was the behaviour of two black-bulb thermometers suspended vertically in free sunshine, and read off as far as practicable at intervals of five minutes. One of the instruments was *in vacuo* and the other in a glass globe containing air. The following table exhibits the variations of the readings:—

Mean Time.	Thermometer in Vacuo.	in Air.	Mean Time.	Thermometer in Vacuo.	in Air.
h m	°	°	h m	°	°
18 35	91·7	78·8	20 20	99·5	89·0
18 40	98·0	82·6	20 25	98·8	88·7
18 45	101·8	85·2	20 30	98·5	88·5
18 50	104·2	87·2	20 35	98·5	88·5
18 55	106·4	89·0	20 40	98·8	88·7
19 0	107·8	90·0	20 45	99·6	89·3
19 5	109·5	91·9	20 50	101·3	90·6
19 20	112·2	95·0	20 55	102·5	91·7
19 25	112·8	95·5	21 0	104·5	93·3
19 30	112·5	95·2	21 5	106·0	94·3
19 35	111·8	95·2	21 10	108·3	95·8
19 40	111·3	95·2	21 16	110·5	97·5
19 45	109·8	94·4	21 20	112·0	98·5
19 50	108·5	94·0	21 25	113·8	99·7
19 55	106·5	92·8	21 30	115·7	101·2
20 0	104·5	91·7	21 35	117·2	101·8
20 5	103·3	91·0	21 40	118·4	102·7
20 10	101·8	90·5	21 50	120·7	104·2
20 15	100·5	89·7	21 56	121·4	105·0

As the atmosphere was calm and the Sun unclouded during the forenoon, these readings afford a good representation of the heating effect of the Sun's rays. It will be seen that the minimum readings occurred nearly simultaneously with the greatest phase of the eclipse.

Windsor, N. S. Wales:
1882, *Nov.* 20.

Occultations of Stars by the Moon observed at Stonyhurst in 1882.
By the Rev. S. J. Perry, F.R.S.

1882.	Phenomena.	Limb.	G.M.T. h m s	Remarks.
Sept. 5	Disapp. of 68 Orionis	Bright	12 5 46·5	Sky perfectly clear.
	Reapp. „	Dark	12 47 43·8	„
21	Disapp. of B.A.C. 6536	Dark	7 46 45·0	Definition very good.
	Reapp. „	Bright	9 1 41·0	„
Nov. 26	Disapp. of χ^3 Orionis	Bright	10 32 30·8	Excellent observation.
	Reapp. „	Dark	11 37 10·3	

The observer throughout was Mr. J. Rooney.

Phenomena of Jupiter's Satellites observed at Stonyhurst in 1882. By the Rev. S. J. Perry, F.R.S.

	Satellite.	Phenomena.	G.M.T.	Corr. of N.A.	Observer.	Remarks.
1882, Jan. 18	3	Ec. D. Fading	5 10 50·9		W.C.	Definition excellent.
		Half light	5 17 22·4			
		Last seen	5 22 1·9	+4 0·9		
18	3	Ec. R. First seen	6 47 36·4	−7 29·6	W.C.	Observation very good. Thin clouds.
24	1	Ec. R. First seen	7 23 32·1	−0 0·9	J.R.	Definition very good.
		Half light	7 24 45·8			
		Full light	7 25 33·7			
Feb. 1	3	Oc. D. External contact	7 36 28·2		W.C.	Definition poor.
		Bisection	7 39 32·7			
		Last seen	7 43 27·5			
15	1	Tr. I. External contact	6 50 8·6		J.R.	Thin clouds passing.
		Bisection	6 52 36·9			
		Internal contact	6 55 46·7			
15	2	Oc. D. External contact	9 24 58·6		J.R.	Definition very good.
		Bisection	9 26 45·1			
		Last seen	9 28 37·5			
Mar. 11	1	Ec. R. First seen	7 57 4·2	+0 18·2	J.R.	Definition good. Haze; passing clouds.
		Half light	7 59 35·0			
		Full light	8 3 21·5			
12	2	Oc. D. External contact	6 53 29·7			
		Bisection	6 56 21·2			

	Satellite.	Phenomena.	G.M.T.	Corr. of N.A.	Observer.	Remarks.
		Last seen	6 58 28·7			
1882, Mar. 17	1	Tr. I. External contact	9 12 44·8		J.R.	Definition very poor.
		Bisection	9 16 24·3			
		Internal contact	9 18 1·6			
26	1	Tr. E. Internal contact	7 56 39·0		J.R.	Definition poor. Image very steady.
		Bisection	7 59 20·0			
		External contact	8 2 10·0			
28	3	Tr. I. External contact	11 39 35·8		J.R.	Definition very good.
		Bisection	11 46 32·0			
		Internal contact	11 51 46·2			
28	3	Tr. E. Internal contact	14 4 2·9		J.R.	Definition very good.
		Bisection	14 10 2·5			
		External contact	14 17 58·8			
Nov. 11	1	Tr. I. External contact	9 34 18·8		A.C.	
		Bisection	9 36 34·8			
12	2	Oc. R. First seen	8 58 27·8		W.McK.	Definition good.
		Bisection	9 0 57·3			
		External contact	9 3 59·3			
17	1	Ec. D. Half light	13 19 40·6		J.R.	Definition fair.
		Last seen	13 21 11·6	+0 38·6		
17	1	Oc. R. First seen	16 19 47·0		J.R.	Haze.
		External contact	16 22 45·1			

	Satellite.	Phenomena.	G.M.T.	Corr. of N.A.	Observer.	Remarks.
1882, Nov. 26	1	Ec. D. Last seen	9 43 35·1	+0 25·1	J.R.	Observation very good.
26	1	Oc. R. First seen	12 30 8·0		J.R.	Definition poor.
		Bisection	12 33 12·8			
		External contact	12 35 43·3			
27	1	Tr. I. External contact	7 25 25·4		J.R.	Definition poor.
		Internal contact	7 30 37·4			
Dec. 5	1	Ec. D. Fading	6 3 24·3		J.R.	Definition good.
		Half light	6 4 36·4			
		Last seen	6 5 45·6	−0 9·4		
5	1	Oc. R. First seen	8 36 55·6		J.R.	Definition good.
		Bisection	8 37 45·1			
		External contact	8 38 52·3			
10	3	Tr. E. Bisection	10 37 22·5		J.R.	Observation good.
		External contact	10 43 53·7			
10	1	Ec. D. Fading	13 29 42·0		J.R.	Definition very good.
		Half light	13 30 36·5			
		Last seen	13 31 51·1			
10	1	Oc. R. First seen	15 53 14·0		J.R.	
		Bisection	15 55 5·5			
		External contact	15 57 8·8			

The observations were all made with the 8-in. Equatorial, the observers being the Rev. A. Cortie, and Messrs. J. Rooney, W. Carlisle, and W. McKeon.

Observations of Occultations of Stars by the Moon, of Phenomena of Jupiter's Satellites, and of the Eclipse of the Sun, 1882, May 16, made at the Royal Observatory, Greenwich, in the year 1882.

(*Communicated by the Astronomer Royal.*)

Occultations of Stars by the Moon.

Day of Obs.	Phenomenon.	Telesc.	Power.	Moon's Limb.	Mean Solar Time of Observation.	Obs.
1882.					h m s	
Feb. 24 (*a*)	Disapp. 53 Tauri	Altaz.	100	Dark	7 45 17·65	T.
Apr. 1	Disapp. *e* Leonis	E. Eq.	70	,,	11 30 52·12	L.
May 27 (*b*)	Disapp. W.B. xii., 334	,,	140	,,	9 43 4·30	A.D.
	Disapp. W.B. xii., 334	Altaz.	100	,,	9 43 4·90	H.
Aug. 2	Reapp. 22 Piscium	,,	,,	,,	10 50 14·80	T.
Sept. 20	Disapp. μ Sagittarii	,,	,,	,,	9 19 21·52	L.
	Disapp. μ Sagittarii	E. Eq.	70	,,	9 19 21·82	A.P.
Oct. 1	Reapp. *l* Tauri	Altaz.	100	,,	17 35 59·87	T.
2	Reapp. χ^2 Orionis	,,	,,	,,	12 21 23·64	H.
22	Disapp. κ Aquarii	E. Eq.	70	,,	10 25 13·27	T.
24	Reapp. 51 Piscium	Altaz.	100	,,	11 49 32·39	H.
Nov. 26	Reapp. χ^3 Orionis	E. Eq.	70	,,	11 38 1·94	L.

Notes.

(*a*) Star faint; cloudy.

(*b*) Instantaneous.

Phenomena of Jupiter's Satellites.

Day of Observation.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
					h m s	h m s	
1882, Jan. 7	III.	Tr. Ingr. First contact	E. Eq.	140	6 29 57		
		Bisection	,,	,,	6 35 6	6 32 0	L.
		Last contact	,,	,,	6 39 56		
7	II.	Occ. D. First contact	,,	,,	7 29 38		
		Last contact	,,	,,	7 34 15	7 32 0	,,
7	III.	Tr. Egr. First contact	,,	,,	8 20 19		
		Last contact	,,	,,	8 30 6	8 26 0	,,
7	I.	Tr. Ingr. First contact	,,	,,	8 28 4		
		Last contact	,,	,,	8 33 9	8 27 0	,,
Feb. 15 (*a*)	II.	Occ. D. Last contact	,,	,,	9 28 6	9 29 0	,,
Mar. 3 (*b*)	II.	Tr. Ingr. First contact	,,	,,	9 47 11		
		Last contact	,,	,,	9 53 10	9 54 0	A.D.
17 (*c*)	I.	Tr. Ingr. First contact	,,	,,	9 14 35		
		Last contact	,,	,,	9 20 4	9 15 0	H.P.
Apr. 3	III.	Tr. Ingr. First contact	,,	,,	7 42 35	7 45 0	A.D.
6 (*d*)	II.	Ecl. R. First seen	,,	70	8 58 32	8 57 40	T.
Oct. 3	III.	Occ. R. Last contact	Altaz.	100	13 12 24	13 7 0	H.C.

Day of Observation.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
					h m s	h m s	
1882, Oct. 4 (*e*)	I.	Occ. R. First seen	E. Eq.	140	11 0 40	11 2 0	H.P.
		Last contact	,,	,,	11 6 9		
25 (*f*)	I.	Occ. D. Last contact	,,	,,	13 11 39	13 10 51	L.
Nov. 17	I.	Ecl. D. Last seen	,,	60	13 20 49	13 20 33	H.P.
25	I.	Tr. Ingr. Last contact	,,	70	13 8 21	13 7 0	T.
27	I.	Tr. Egr. Bisection	,,	,,	9 48 10	9 48 0	H.
		Last contact	,,	,,	9 50 27		
Dec. 18	I.	Tr. Ingr. Last contact	,,	,,	12 49 54	12 44 0	T.
19	I.	Occ. D. First contact	,,	310	9 47 28	9 50 0	A.D.
		Last contact	,,	,,	9 52 12		
19	I.	Occ. R. First seen	,,	,,	12 3 46	12 6 0	,,
		Last contact	,,	,,	12 8 20		
21	I.	Ecl. R. First seen	S. E. Eq.	285	6 34 51	6 34 51	,,
		Full brightness	,,	,,	6 38 10		
21 (*g*)	I.	Ecl. R. First seen	E. Eq.	310	6 34 41	6 34 51	L.

Notes.

(*a*) *Jupiter's* limb diffused. (*b*) *Jupiter's* limbs boiling: observation considered very rough. (*c*) Planet steady.
(*d*) ,, ,, (*e*) *Jupiter's* limb diffused. (*f*) *Jupiter* extremely tremulous: observation not considered good.
(*g*) *Jupiter's* limb very ill-defined.

Eclipse of the Sun, 1882, *May* 16.

Beginning and Ending of the Eclipse.

	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation.	Obs.
1882.				h m s	
May 16	First contact	S.E. Eq.	500	18 11 15·24	W.C.
(*a*)	,,	Altaz.	120	18 11 27·11	A.D.
	Last contact	S.E. Eq.	500	19 23 13·43	W.C.
(*b*)	,,	Altaz.	120	19 23 8·55	A.D.
	,,	E. Eq.	70	19 23 9·25	M.
	,	N. Eq.	220	19 23 1·42	L.

Notes.

(*a*) Observation satisfactory. (*b*) Observation pretty accurate.

During the eclipse the following observations were made with the S.E. Equatorial:—

From 18 h 13 m to 18 h 31 m G.M.T.	10 differences of	R.A. of *p* and *f* cusps.
18 31 to 18 48	10 ,,	N.P.D. of limbs of Sun and Moon.
18 48 to 19 8	8 ,,	R.A. of *p* and *f* cusps.
19 8 to 19 22	9 ,,	N.P.D. of *p* and *f* cusps.

The clear aperture of the object-glass of the S.E. Equatorial is $12\frac{3}{4}$ inches, of the E. Equatorial $6\frac{3}{4}$ inches, of the Altazimuth 4 inches, and of the N. Equatorial 4·1 inches.

The initials W.C., A.D., M., T., L., H., H.P., H.C., are those of Mr. Christie, Mr. Downing, Mr. Maunder, Mr. Thackeray, Mr. Lewis, Mr. Hollis, Mr. H. Pead, and Mr. Cox.

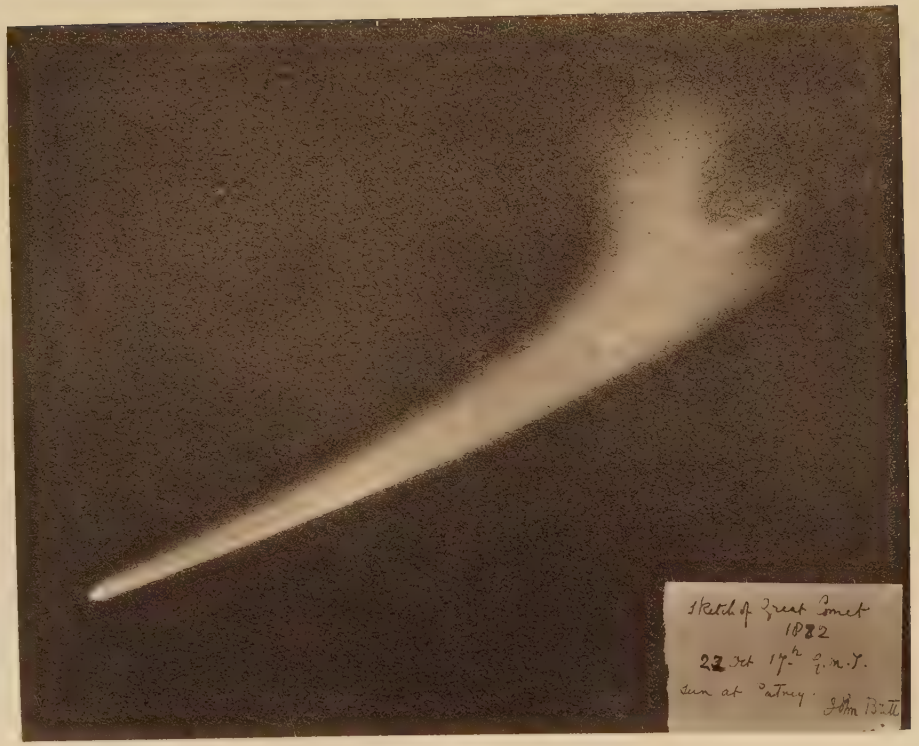
Royal Observatory, Greenwich:
1883, *January* 20.

Observation of Comet a, 1883, *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The observation was made with the East or Sheepshanks Equatorial, by taking transits over two cross wires at right angles to each other, and inclined 45° to the parallel of Declination.

Green. Mean Solar Time.	Obs.	δ−✶ R.A.	δ−✶ N.P.D.	No. of Comp.	Apparent R.A.	Apparent N.P.D.	Star.
d h m		m s	′ ″		h m s	° ′ ″	
Mar. 8 9 0	H.	+0 11·0	−2 58″·96	1	0 59 56·62	58 23 36″·81	*a*



SKETCH OF THE GREAT COMET (*b*), 1882.

BY JOHN BRETT.

Mean Place of Comparison Star.

Star.	Star's Name.	R.A. 1883·0.	N.P.D. 1883·0.	Authority.
		h m s	° ′ ″	
a	σ^2 Piscium	0 59 45·24	58 26 40·50	Green. Cat. 1872.

Note.—The sky clouded immediately after the comet was found; only one comparison could be obtained.

The observation is not corrected for refraction or parallax.

Royal Observatory, Greenwich:
1883, *March* 9.

Observations of the Great Comet (b) 1882, *made at Grahamstown, Cape of Good Hope.* By L. A. Eddie.

The comet was first observed on September 13 at 4.50 A.M. It had then just risen above the horizon, and appeared in the strong twilight as a brilliant but narrow band of ruddy light, terminating in a very bright nucleus, equalling *Jupiter* in brilliancy and apparent size. The tail was slightly inclined to the north, but seemed to have no curvature. It could be traced to about 12° from the nucleus. When viewed through my 9½-inch Calver, it appeared as an extremely bright and well-defined nucleus of a solid appearance, and shining with a light quite equal to that of *Venus*, but of a light golden hue; it was surrounded by a dense coma of a ruddy-brown tinge; there was no appearance of envelopes, and its periphery was very sharply defined. The nucleus seemed to contract as the daylight increased until it reached a limit where the still increasing light had no further diminishing effects on its size. This would seem to indicate a very dense centre to the nucleus.

September 15.—Morning clear. Head of comet rose at 5.3. The nucleus shone as bright as *Jupiter*, but no important details of physical structure were observed. The nucleus could be seen with the naked eye up to 5.40.

September 16.—The comet rose at 5.15. In the telescope the nucleus appeared less sharply defined on its preceding boundary, and the breadth of the coma was greater on the northern side than on the southern. The tail seemed to spread out for a short distance behind the comet, and it was darker in the centre, as if split open.

September 17.—The comet rose at 5.44, about 14 minutes before the Sun. It had increased still more in size and brilliancy. The head and tail, about 8′ in length, shone with intrinsic lustre. It was not to be eclipsed by the sunlight to-day at all, but continued to shine during the whole day as a bright attendant to the Sun, of 1° in length, and in which the cometary form was plainly discernible. So apparent was it to the naked eye, that one had but to look in the direction of the Sun when it could immediately be seen without any searching. However, as the day advanced it approached the Sun so very rapidly that at

2 o'clock there was some little difficulty in screening the Sun from the view when looking at his attendant; and at 4.30 P.M. —which was the latest I was able to observe it, owing to its becoming obscured by clouds—it was so very close to the Sun as to be visible in the same field with this orb when observed through my 3-inch Refractor with a power of 50, being then about 14′ only from the Sun's western limb. In the 9-inch Calver this splendid object certainly presented a beautiful and imposing sight when it had risen sufficiently high to be free from the effects of the unsteadiness of the atmosphere in the vicinity of the horizon. The nucleus appeared as a solid globe glowing with a white light surpassing that of *Venus* when viewed in the daytime. The coma and tail for a short distance behind the head were also very brilliant. There was but little coma preceding the nucleus, so that the latter appeared as situated at almost the extremity of the tail. The coma was bounded on the margins by a denser stream of light than that composing its interior portion, and the northern side was narrower and brighter than the southern, but the southern extended further behind the nucleus than the northern. For this comet to have been not only visible during the whole day, but to have formed a conspicuous object in the heavens while in such close companionship with its brilliant ruler proves it to be the most brilliant comet of the present century, not excepting the great comet of 1843, which was also visible in full daylight, but not described as being visible during the whole day. To prove that it was not only visible in full daylight to one experienced in searching for heavenly bodies, I may here mention that my little girl, of only four years, was able to see it without difficulty up to about 1 o'clock, after her attention had been once directed to it. What is remarkable in this comet is that no great indications of perturbations taking place in its physical structure were observed while it approached the Sun, as is generally the case with these wonderful bodies, and especially with that of Comet *b* of 1881, as observed by myself.

September 19.—Comet observed at 8 A.M. about 4° N.W. of the Sun. It is now moving off in almost the same direction as it approached the Sun, so that it is apparently describing a very closed orbit of an elongated elliptical form.

September 20.—The comet rose at about 5.15 A.M. Though the head is decreasing in brightness, the tail has certainly greatly increased both in breadth and length. The tail appeared 5° in length and about 1½° in width. It spread out suddenly to a breadth of nearly 1° at about 2° behind the nucleus, and then continued to open out at a less angle.

September 24.—On observing the comet at 4.30 A.M. a most glorious sight presented itself. The head of the comet had not yet risen, but a broad brilliant belt of rich golden light, about 2° in breadth, streamed upwards from the horizon for about 10°; and from the northern margin of this, again, a thin streak of less brilliant light extended upwards for about another 12°, and when

the head had fully risen above the horizon at 4.43 A.M., there were about 25° in length of intensely luminous matter stretching upwards from a still more brilliant head, and inclined to the horizon at an angle of 70°. This glowing glory of light was more intensely brilliant on its margins, which represented two streams of incandescent gas flowing out from the preceding portion of the nucleus for a short distance, and then bent backwards so as to form the boundaries of its luminous appendage. The northern streamer was rather more brilliant than the southern, and possessed a slight bowing or outward curvature near the head of the comet, and further it was bounded on its interior edge by a dark rift or interval, which extended from the nucleus to nearly the termination of the broad part of the tail, and though it appeared very dark indeed when viewed with the luminous portion in close juxtaposition with it, it was nevertheless detected to possess a small degree of luminosity when viewed alone. The head appeared as before to consist of an apparently very solid though not very large nucleus, surrounded by a dense coma of no great extent, especially preceding the nucleus, and possessing no dark intervals, envelopes, or indeed any remarkable details as were so very conspicuous in Coggia's Comet of 1874, and in Comet *b* of 1881. As daylight advanced it soon became apparent that the comet, though not before seen to so great advantage, owing to its rising earlier, and consequently projected on a darker background, had greatly decreased in brilliancy and apparent size, for it was eclipsed by the increasing daylight, about 12 minutes before sunrise, when *Jupiter* was yet plainly visible. The Sun rose about 4.49.

October 3.—The comet rose at 3·35, and could be then seen, through the dense fog that prevailed, like a great flame proceeding from a bonfire on the hills. At 4 A.M. when the fog had cleared away, it was at once perceptible that a great change in the structure of the comet had taken place. The tail was about 15° in length, and 3° in breadth at its extremity. The light was much more diffused throughout the whole length and breadth than before. The bright streams of light on the margins had disappeared; but the southern side was brighter, more sharply defined, and seemed to consist of denser matter than the northern, which was ragged in some parts, and shaded gradually in others. The dark rift which formed so conspicuous an object on September 24 was still present, but appeared to be closing up. There was a less sharply defined dark rift proceeding from the centre of the extremity of the tail to about $\frac{1}{4}$ its length towards the head, not parallel with the tail, but, following it with the eye from west to east, it appeared to incline more to the northern margin. The long, but faint, extension of the tail on the southern side was not visible; but this was probably owing to the strong moonlight, for when the tail was viewed by a side glance, a slight extension of the southern margin beyond the northern could be traced. The intense brilliancy of the tail to about two degrees behind the nucleus,

which was plainly perceptible in this comet even when viewed in the daytime, has almost entirely left, and seems to be diffused throughout the whole tail, so that the extremity is now almost as brilliant as the portion immediately behind the nucleus. The head and one-fourth of the northern margin of the tail to about 3° behind the head were shrouded by a faintly luminous envelope of very rare matter one-fourth of a degree in width. The southern margin of the tail was, as I have already stated, very sharply defined, and possessed a slight though decided curvature.

On examining the nucleus with the $9\frac{1}{2}$-inch Calver, to my astonishment I observed that it consisted of two distinct ellipsoidal nuclei in juxtaposition, each of them brighter on the interior edge and drawn out as it were towards the comet's ulterior boundary so that their conjugate axes were about double their transverse. They closely resembled, in the inverting telescope, the flames of two candles placed the one above the other, so that the uppermost part of the lower flame almost overlapped the lower portion of the other. There was a dark rift the breadth of the transverse axes of these nuclei extending from the hindermost one into the tail. These two nuclei were not parallel with the axis of the comet, but the foremost was drawn as it were, to the south or nearer to the direction in which the comet is moving. These two gaseous bodies appeared exactly as the double star *α Centauri* when viewed through a cloud with a low power. When the daylight had partly advanced they could be seen in the telescopic field perfectly free from the light of the surrounding matter forming the coma. This goes to prove what I have above stated, that the brilliancy of the matter immediately around and behind the nuclei has now greatly declined, for a considerable portion of the luminous matter forming the coma and tail was always visible on former occasions in the telescopic field when observing the nucleus, even at midday and when close to the Sun.

The comet became invisible this morning at 5.17, when the first-magnitude stars were yet shining brightly. The Sun rose at 5.35.

October 4.—Comet this morning very beautiful, owing to the sky being perfectly free from cloud or mist of any description. At 4 o'clock the prolongation of the southern margin of the tail could be traced for a short distance beyond the normal tail. The dark rift extending the whole length of the tail was still less distinct, and seems to be fast disappearing. The thin gauze envelope around the head and part of the tail is becoming more extensive, being in some parts nearly one degree in width, and it appears to melt into and form a continuation of the gradual shading off of the northern margin of the tail, which was this morning much less ragged. If it were not for the strong moonlight this thin veil would form a very beautiful and conspicious feature in this comet. When viewed through the finder it appeared sharp and well-defined, and extended for a considerable distance beyond the nuclei. The nuclei this morning were dis-

tinctly divisible viewed in the Reflector with powers of 60 and 100. They appeared if anything smaller than yesterday. The preceding nucleus was larger and brighter than the other, and they resembled in shape two grains of rice placed end to end.

October 8.—The dark rift that extended through the tail near its southern margin has entirely left, though the appearance of longitudinal streaks is still more apparent on this side. The abnormal tail could be traced for about 3° beyond the normal tail, making a sort of ogee-shaped figure on the extremity of the southern margin of the latter. In the finder, the thin gauze veil observed October 4, which envelops the head, as it were, with a hood, could be distinctly seen spreading out on either side of the head and extending to a considerable distance in front of the head in a cometary form, but lost to vision or fading away at the extreme limit of the cone. The nucleus, when viewed with the 9-inch Calver, powers 60 to 100, was very indistinct, owing partly no doubt to the unfavourable state of the atmosphere for observation; the preceding portion of the nucleus was shining brightly and did not seem to have altered since I last saw it, but the following portion was as if drawn out, and the light condensed at either end of the longer axis, so as to give the whole nucleus a triple appearance, but without any distinct separation between the two parts as before observed, or between the three apparent centres of condensation; it resembled a bar of dim light threaded with three beads of greater brilliancy, the foremost a long oval one, the others round, smaller and less brilliant. The light of the waning moon was unfavourable to observing details in the structure of the comet.

October 9.—Morning clear, but wind very strong and atmosphere unsteady. The light midway in the length of the tail is rather dimmer than at either of the extremities. Nucleus had much the same indistinct triple form as yesterday, and is now surrounded by very little coma. The hood surrounding the head, when viewed through the finder, has still the same beautiful appearance.

October 11.—Morning very fine, with clear sky and steady atmosphere. The thin gauze hood to the head of the comet was faintly discernible to the naked eye for about $1\frac{1}{2}^\circ$ in front of the nucleus, and this feature is still very beautiful in the finder. I obtained this morning a much more satisfactory view of the nuclei than I did on October 8 and 9. They have greatly altered in shape since I first detected the division, and they have also somewhat considerably opened out. The preceding nucleus is now much smaller and condensed into a very bright starlike point, from which spiral streams seem to emanate. The hindmost nucleus has become greatly elongated, and now possesses as it were two centres of condensation, and appears to be fast approaching to a further division. This elongated nucleus resembles a dumb-bell with the sphere towards the tail more oval than the other. When the splitting up of the nucleus was first discovered by me, the two portions

resembled two oval flames brightest on their internal edges—that is, at the ends nearest the tail of the comet: now the present elongation of the inner nucleus also represents two oval flames, but whose external edges are brightest—that is, on the ends nearest to the extremity of the head of the comet. These flames seem to overlap one another, the dimmer edge of the foremost overlapping the brighter edge of the hindmost. The whole nucleus appears, when not quite resolved, as a beaded streak of light inclined at an angle to the axis of the comet towards the southern limit of the head. The northern extremity of the tail was very close to *Cor* (*a*) *Hydræ*. The normal tail was about 15° in length, and if we add to this about 3° prolongation of the southern margin, and $1\frac{1}{2}$° or 2° of dim mist extending beyond the head, we shall have, as visible this morning, an object stretching over 20° of the heavens. The nucleus faded from sight at 4.55, just half-an-hour before sunrise, when *a Hydræ*, a second-magnitude star, was yet visible.

October 15.—Morning fine for observation. Observed comet from 2.46 A.M. Nucleus situated about 4° East by South of λ *Hydræ*, which star it grazed with northern edge of tail and extended upwards to a small fifth-magnitude star (27 *Hydræ*) a little south-west of *a Hydræ*. The prolongation of the southern margin terminated near another fifth-magnitude star (26 *Hydræ*). The northern margin was also drawn out, but not so far as the southern, giving the termination of the tail an appearance of two horns with a bright point, formed by these small stars, on each of the tips, the southern horn being longer than the northern. A faint mistiness resembling the fainter portions of the milky-way could be traced to about 10° beyond the southern prolongation of the tail, when viewed with an averted glance. The portion of the tail which had passed over λ *Hydræ* was situated 4° from the nucleus, and was about 2° in width. A sixth-magnitude star, ν^2 *Hydræ*, $1\frac{1}{2}$° south-west of λ *Hydræ*, was shining through the tail. The head when viewed through the finder was still surrounded by the faint though beautiful and extensive cone of light forming the hood, which is rather wider on the northern than on the southern side.

The nucleus when viewed through the Reflector, power 60, still appeared of a triple nature, though the second and third points of light (counting from east to west) were connected. The preceding point, which was distinctly separated from the others, was very brilliant, and resembled in colour the electric light; the spiral streams proceeding from it could also be seen. The preceding condensation of the other portion of the nucleus (Point No. 2) was also tolerably brilliant; but the following condensation (Point No. 3) was much dimmer and less defined. With power 100, each of these condensations in the bar of light forming the hindermost portion of the nucleus seemed at times again doubled, so that the whole nucleus resembled a string of five ill-defined luminous beads, or as one of the chords of an abacus threaded with five shining beads, the lower—or, as they

appeared in the inverted telescopic field, the upper—the brightest and separated from the remainder, which graduated in brilliancy from the highest to the lowest. Comet faded from sight at 4.41; Sun rose at 5.20.

October 16.—The southern extension of the tail was visible for a long way beyond the termination of the normal tail when the comet rose; but, cirri clouds having spread themselves across the sky, no observations could be made with the telescope.

October 21.—Nucleus still bears power 100 with the $9\frac{1}{2}$-inch Calver. The beaded appearance is now still more apparent. The brightest point, which before formed the foremost or more eastward, is now shorn of the spiral streams which emanated from it, but it is preceded by another faint point of light some distance away, with which it is connected by a hazy light. This will, in description, now form the first point. The third is also a tolerably bright point, but not nearly so bright as the second, from which it is still separated by a dark interval. This point followed by three other points of less brilliancy, enveloped as it were in a mist. The most westward of these points was only visible at intervals. The whole object resembled a sextuple star, divided by a dark interval into two groups, consisting respectively of two and four components, and each of these groups surrounded by a nebulous mist, the components of both groups being in one straight line, perpendicular to the line of sight.

October 23.—Sky clear. Comet shining brightly, no perceptible change to the unaided eye. Nucleus bore power 100 well. It now forms in the mirror a very conspicuous elongated objected studded as it were with six twinkling stars. The new point (Point No. 1) preceding the brightest point (Point No. 2) was this morning brighter and separated a little farther from the latter than on October 21. The dark interval between the two portions of this compound nucleus is still very apparent, and the force that produced this rupture seems still to be active in these two portions of the original nucleus, but to be acting in opposite directions in each. This is apparent by the fact that the preceding portion has formed a new point or jet in front or eastward, while the following portion has formed three points or jets behind or westward. This beaded bar of light composing this wonderful nucleus measured this morning about 1′ 15″ in length. All the bright points were better defined than I have yet observed them. The comet faded from sight at 4.35 A.M.; the Sun rising at 5.10 A.M.

October 29.—Nucleus in telescope fairly distinct; all six points discernible. No. 1 point appeared rather further removed, otherwise the whole streak forming the nucleus seemed shorter and fainter, from its being now at a much greater distance from the earth. The tail, however, was nothing diminished in length, though of course the prolongation of the southern margin can no longer be seen, owing to the bright moonlight.

November 1.—Nucleus presented no apparent change, except that it was more indistinct, so that the fifth and sixth points

could not be detected, and the division between the two portions was very much smaller and less distinct.

November 2.—Morning fine; atmosphere clear; moon nearly the same altitude as comet, but considerably to its north. Nucleus was resolved into the six points by the $9\frac{1}{2}$-inch mirror; the fifth and sixth require now a very clear morning in order that they may be detected, but this morning they were clearly visible. The two principal points, Nos. 2 and 3, were very bright.

November 10.—Sky covered more or less with cirri. Observed comet from 3.30 A.M. till eclipsed by daylight. Nucleus appeared to unaided eye much brighter and more star-like. With the mirror I was able to see all the points except the sixth, also the division between Points Nos. 2 and 3. The last formed point (No 1) has dimmed less than the others, or is, in other words, comparatively brighter than formerly. It is also now situated at a further distance from its neighbour than any of the others are from each other. The nucleus was visible to the naked eye up to 4.20—that is, thirty-three minutes before sunrise, which was at 4.53. This fact shows that there is apparently no diminution in the light of the nucleus since October 23 last, when, according to my own observations of that date, the comet faded from sight at 4.35 A.M. (the Sun rising at 5.10) or thirty-five minutes before sunrise. Its apparent movement is at present very small.

November 17.—Comet visible for a short time from 2.30 A.M. to 3.15 A.M. I could still, when using the $9\frac{1}{2}$-inch Calver, detect at intervals five of the bright points in the nucleus. I thought Point No. 5 twinkled into sight more often than it had for some time back, while Point No. 1 could, on this occasion, scarcely be detected. Point No. 6 has now quite disappeared. These extremely tiny points of light, situated as it were in a nebulous mist, and revealing themselves at intervals on very favourable nights only, by their twinkling do indeed present a wonderful phenomenon.

November 24.—Sky clear; moon nearly full and very bright. The nucleus of the comet when viewed in the telescope still presented the appearance of a bar of light, but I could distinguish only two of the points of light, which I could not identify.

November 27.—Nucleus in $9\frac{1}{2}$-inch Calver appeared granulous.

November 31.—The tail of the comet is still about 12° in length, and rather wider than formerly. The extremity has greatly altered in form, being now very much curved downwards to the east, in the form of a shepherd's crook, and closely resembling an ostrich plume with a drooping tip. The extremity is fully 6° in width. On examining the nucleus in the telescope, Point No. 1 could be seen very far removed from Point No. 2, which latter, together with No. 3, could be discerned on close observation.

December 2.—Sky hazy. Comet bright. The hooked extremity of tail plainly discernible.

December 4.—Nucleus seen at intervals between the breaks in the clouds. Three of the points dimly visible: the streak of light, which now alone forms the centre of the nucleus, resembles a string of luminous beads almost hidden by a luminous gaseous veil stretched over them. A decided change is going on in the nucleus, which does not seem to be decreasing much in brilliancy at present. The tail was tolerably bright for about 8° from the nucleus, when it became very faint, and the "shepherd's crook" was scarcely visible. It was about 2° in width, at a distance of 4° from the head.

December 5.—Comet fainter. Nucleus oval and granulous.

December 9.—Comet resembles an elliptical nebula condensed along its conjugate axis. I can no longer detect the points.

The comet was observed on every day that it was visible from September 13 to December 14, the telescope employed being a $9\frac{1}{2}$-inch silvered-glass Reflector by Calver.

Grahamstown, Cape of Good Hope.

On the Magnifying Power of a Telescope. By J. M. Schaeberle.

(Communicated by W. H. M. Christie.)

I have lately devised a very simple arrangement by means of which the magnifying power of a telescope can be determined with almost any desired degree of accuracy. The only apparatus required is a thin wooden arm about two feet in length, by three or four inches in width at one end, tapering to an inch or less at the other end, and pierced by two fine needles, one near each end of the arm. The needle near the wide end is driven into a table, or any horizontal surface, and serves as an axis about which the arm can be revolved. Directly over this axis the eyepiece is placed in such a position that a narrow slit not more than $\frac{1}{100}$ of an inch in width (formed by fastening two pieces of tin or paper over the opening in the cap which covers the eye-end of the ocular) shall be coincident with the prolongation of the axis of rotation. The optical axis of the eyepiece having been made horizontal, the observer, stationed behind a second but wider slit placed at a distance of several feet from the ocular, and on the same level with it, marks the two positions of the arm (by pricking holes into the table with the other needle) at which the diffused light, passing first through the eyepiece, then through the narrow slit towards the observer, is occulted by the diaphragm in the focus of the eyepiece. If r denotes the distance between the needles, and d the distance between the two prickings in the table, the angle A, subtended by a diameter of the diaphragm, as seen through the eye-end of the ocular, will be given by the equation

$$\sin \tfrac{1}{2} A = \frac{\frac{1}{2} d}{r}.$$

If t denotes the time required for a star, near the meridian

and having the small declination δ, to cross a diameter of the diaphragm, the eyepiece being now attached to the telescope, the expression for the magnifying power P will evidently be

$$P = \frac{\tan \frac{1}{2} A}{\tan \frac{1}{2} (15 . t \cos \delta)}$$

essentially the formula given by Rev. W. Dawes in vol. xxiii. of the *Monthly Notices* of the Royal Astronomical Society. This ardent astronomer there gives a way for finding this angle directly, but for several reasons the results obtained by the method can only be regarded as rude approximations, and he evidently so considered them at the time, for in the same paper he concludes that probably a more accurate way for finding this angle would be to deduce it from the known magnifying power determined by other methods. Now, a comparison of the results obtained by the different methods with which I am familiar leads me to affirm that the most accurate procedure by far, for determining the magnifying power, involves the *direct measurement* of the angles subtended by the diaphragm (or any other plane figure placed in the common focal plane of the objective and eyepiece) as seen from the object and eye ends of the telescope.

An example showing the superiority of this method over the one most commonly given will best illustrate what has been claimed above. Let the effective diameter of the object-glass be 9 inches, and the actual magnifying power 300. The theoretical diameter of the image of the object-glass as formed by the eyepiece when it is placed in the stellar focus will be 0·03 inch. Now, the mean of a most careful series of measurements of the diameter of this image, called the bright spot, may easily be in error several thousandths of an inch: an error of only one one-thousandth of an inch would cause an error of ten diameters in the resulting magnifying power. If we suppose that a diameter of the diaphragm in the eyepiece subtends an angle of 6′ at the objective, we have the following figures:—

Measured Diameter of Bright Spot.	Resulting Power.	Resulting Angle A.
in.		° ′
0·029	310	30 16·5
0·030	300	29 20·5
0·031	290	28 24·2

Now, granting that the mean of a series of *direct measures* of the angle A is in error one whole minute of arc, the resulting power will be in error only 0·18 of one diameter. In general, if n represents the number of minutes of arc subtended at the objective by a diameter of the diaphragm in the stellar focus, and x the number of minutes that the angle A is in error, the

number of diameters or parts of a diameter that the resulting power is in error will be

$$\frac{x}{n}.$$

The angle A will be slightly in error if, when measuring, the slit on the eyepiece is not directly over the axis of rotation; this parallactic error can be rendered insensible by removing the fixed slit, behind which the observer is stationed, to a greater distance, an assistant rotating the arm. If the observer possesses a spyglass (or temporarily constructs one made of two lenses) having a wire or straight-edge placed in the field of view, more accurate and convenient measurements can be made, as both slits can then be dispensed with, the spyglass being focused on the diaphragm as seen through the eye-lens in a negative ocular or a single-lens eyepiece, and both lenses in a positive one. Moreover, the parallactic displacement of the lens due to its eccentric position as it revolves about the axis of rotation now introduces no error in the measurements, so that the telescope can be placed close to the eyepiece.

If a theodolite, having a finely-graduated horizontal circle, is available, the eyepiece can be placed over the vertical axis and the angle, measured as above, deduced from the circle readings.

It is hardly necessary to state that the diaphragm, or wires, used in determining the magnifying power, should not be at too great an angular distance from the optical axis of the eyepiece, the fixed star, used in determining the time of transit, should still be in good focus when near the edge of the field of view, and instantly occulted as it apparently touches this edge.

To find the focal constant of the eyepiece with great accuracy the distance between the stellar focus of the objective and the optical centre of the object-glass must first be determined, and probably the simplest as well as the most reliable method for finding this constant is to rule three fine straight lines upon a piece of mica plate, one of the lines being drawn at right angles to the other two; the distance D between the parallel lines subtending, at the objective, an angle of from 25′ to 50′ when placed symmetrically with respect to the optical axis in the stellar focal plane. If τ denotes the time required for the image of a star near the meridian, and having the small declination δ (viewed with a positive movable eyepiece which can be held in the hand), to pass over the linear distance D on the plate, the focal constant F of the objective will be given by the equation

$$F = \tfrac{1}{2} D \,.\, \tan\left(90° - \frac{15}{2}\tau \,.\, \cos\delta\right),$$

The expression for the focal constant f of the eyepiece is then :—

$$f = \frac{F}{P},$$

P being determined from the direct measurements of the angles

subtended by any plane figure placed in the common focus of the objective and eyepiece as seen from the two ends of the telescope.

Ann Arbor, Mich.. 1883, *Feb.* 5.

Physical Observations of Jupiter. By W. F. Denning.

Mr. Marth has discussed (*Monthly Notices*, vol. xlii. pp. 427–433) the observations of the white equatorial spot made between 1880, Aug. 27, and 1882, Aug. 7, and finds the rotation period $9^h\ 50^m\ 7^s{\cdot}42 = 878°{\cdot}46$ daily rate. This is the same object as that observed by Prof. Hough (Annual Report of the Dearborn Observatory, 1882, pp. 50,51) from 1880, Oct. 28, to 1882, March 31, and for which he has determined the period to be $9^h\ 50^m\ 9^s{\cdot}8$. The great red spot which has formed so conspicuous an object on the planet during the few preceding years has now become extremely faint, and it appears probable that it may shortly disappear. Its retarded motion continues. On 1883, Mar. 18, it crossed the planet's central meridian $1^h\ 29^m{\cdot}4$ after the assumed first meridian, as computed by Mr. Marth from the period $9^h\ 55^m\ 34^s{\cdot}47$ ($=870°{\cdot}42$ daily rate). Relatively to this adopted time of rotation the spot has lost about 4^m per month, owing to its slackening velocity, since early in May 1881. The comparative motion of this red spot and of the white equatorial spot continue to afford some interesting results. From observations on 1883, March 15, the epoch of conjunction of the two markings was found to be, 1883, March 15, $13^h\ 38^m$. The figures show that since 1880, Nov. 19, $9^h\ 23^m$—a period of $846^d\ 4^h\ 15^m$—the white equatorial spot had completed 19 revolutions of *Jupiter* relatively to the red spot, the number of rotations performed by the latter being 2045 and by the former 2064. The white spot continues to be as brilliant and well-defined as when it first attracted notice, and gives promise to remain visible for a very lengthened period.

Bristol: 1883, *March.*

Note on Observations of Mercury. By W. F. Denning.

I obtained observations of this planet just before sunrise on the mornings of November 6, 7, 9, and 10, 1882, with my 10-inch Browning Reflector, power about 212. Some dark, irregular spots were distinctly seen upon the planet; also a small brilliant spot, and a large white area between the E.N.E. limb and terminator. The south horn was also much blunted, especially on the two first dates of observation. My results have led me to infer that the markings upon *Mercury* are far more decided and easily discernible than those on *Venus*; and that the aspect o the former planet presents a close analogy to the physical appearf ance of *Mars*. The rotation period of $24^h\ 5^m\ 30^s$ given b- Schröter seemed too short to conform with the relative placy

of the markings as I delineated * them on the several dates referred to; and I wrote to Sig. Schiaparelli, of Milan, enclosing him the particulars of my results, as he has latterly been observing this planet with signal success. In discussing my notes he says:—"You were right in saying that this planet is much easier to observe than *Venus*, and that his aspect resembles *Mars* more than any other of the planets of the solar system. There are spots sometimes partially obscured and sometimes completely so; there are also brilliant white spots in a variable position. You are also right in suspecting that the rotation of Schröter was not exact." Sig. Schiaparelli mentions that his most successful results have been obtained with the planet near superior conjunction, when the defect of the diameter was compensated for by seeing nearly all the disk, which is then more strongly illuminated than near dichotomy.

I wish to call brief attention to these observations, in the hope that observers having equatorially-mounted instruments will examine the planet near superior conjunction. Sig. Schiaparelli has evidently utilised his favourable climate and instrumental means to obtain some important clue to physical phenomena of much interest on this systematically neglected member of our system.

Bristol: 1883, *March* 5.

On the Account of William Ball's Observation of Saturn in the Philosophical Transactions. By Henry T. Vivian.

I have read with great interest the paper by Professor Adams on this subject in the January number of the *Monthly Notices*; but notwithstanding the able manner in which he has dealt with it, it does not appear to me that the difficulties connected therewith, of which he speaks in the early part of his paper, have been altogether removed. There is an explanation, which perhaps has not occurred to Professor Adams, that, I think, may do something towards rendering the matter a little less obscure, and which will make the account in the *Philosophical Transactions* consistent with Ball's observation and his own account of it in his letter.

If we look at the request of the "Person to whom notice was sent" as an attempt to revive, in opposition to Huyghens, the opinion of Hevelius, that *Saturn* was elliptical and enclosed between two circular-shaped bodies, one on each side of him, we shall have this fully supported by the observation of October 13, as may easily be seen by supposing the outline of the planet in fig. 3 to be completed. The account of Ball's observation may then be considered accurate, and the figure correct. This view of the matter appears also to be supported by Ball's first letter of April 14. That letter alludes to observations made in three

* These drawings are on the eve of publication in the French serial *L'Astronomie.*

several years—viz. in 1664, the autumn of 1665, and in 1666. In 1664, he says, the figure of *Saturn* was the same as in 1666 —*i.e.* like the small fig. at the end of the postscript; and that in 1665 it was "what Sir R. Moray communicated," which is, no doubt, that alluded to in the account in the *Philosophical Transactions*, and represented in fig. 3.

One other point is perhaps worth inquiry. The Ball referred to by Huyghens is spoken of as D. Ball, whilst the Ball of the *Philosophical Transactions* is William Ball. May they not have been two different persons?

London: 1883, *March* 3.

[*Note on the above Paper, by Professor Adams.*—The explanation seems to be that the account of Ball's observation is accurate, and the figure given in the *Philosophical Transactions* correct. But this ignores the fact that all modern observations show that *Saturn's* ring has no such figure as that represented by the paper cutting, and it also supplies no reason for the suppression of the plate containing the extraordinary figure of the ring. The suggestion that the D. Ball spoken of by Huyghens is a different person from the William Ball who made the observations is quite untenable. Huyghens wrote in Latin, and D. Ball is merely an abbreviation for *Dominus* Ball. There were two Balls, William and his brother, but the former was the astronomical observer.]

Report of the Work of the Royal Observatory, Cape of Good Hope, during the year 1882. By David Gill.

During the past year the general programme of last Report has been systematically followed, and some additional researches have been undertaken.

1. The observations for the telegraphic connection of the longitudes of Aden and this Observatory, including the necessary personal-equation determinations, were completed on February 22, 1882, and the places of all the stars employed in the work have been re-observed with the Transit Circle.

The reductions of all these Transit Circle observations and of the personal-equation determinations are completed, as also are the determinations of clock error at all the stations except Aden. The latter were delayed in expectation of recent places of a few Northern circumpolar stars. The whole of the reductions of this work will now be completed within a few weeks.

2. The places of the Moon from Hansen's Tables, corresponding to the instants of occultations observed at the Cape previous to 1860, have been communicated by Professor Newcomb. The resulting equations have been computed, and the complete work only now requires the application of small corrections for error in the assumed longitude of the Cape.

3. The Cape Catalogue for 1850 has been delayed in comple-

tion by the severe pressure of current work, and this pressure has been increased by the illness of Mr. Freeman, Fourth Assistant. The reduction of corresponding stars in Mr. Stone's Catalogue to the Equinox of 1850 has, however, been made, and the whole only now requires final revision and comparison.

4. The meridian observations of 331 standard stars for the future zone observations of Professor Schönfeld's *Durchmusterung* from N.P.D. 90° to 120°, as also of the specially selected stars observed for refraction in conjunction with Leiden, have been proceeded with. The requisite number of observations have been obtained for all these stars except for some of those between 22^h to 5^h R.A. inclusive—where the observations of *Victoria* and *Sappho*, and the absence of observers in connection with the Transit of *Venus*, interfered to prevent their completion.

The meridian observations of the past year also include circumpolar stars, comet comparison stars, special observations of α and β *Centauri*, stars used in researches in stellar parallax, zones of stars observed in conjunction with the German Transit of *Venus* Heliometer expeditions, stars of which occultations by the Moon have been observed, and some comet observations.

In the year 1882 the number of observations with the Transit Circle has been as follows:—

In Right Ascension ...	...	4530 observations
Polar Distance ...	...	3844 „

248 determinations of level, 253 of azimuth, 161 of collimation.

The observations are all reduced to the end of 1882, but examination is in arrear for the greater part of that year.

5. Thirty-six occultations of stars by the Moon have been observed during the year 1882.

6. *Comets.*—Comet *Wells* was observed with the $8\frac{1}{2}$-ft. Equatorial on thirty-nine days between June 14 and August 16 inclusive. The results are published in the *Monthly Notices* (vol. xliii. No. 1).

It was also observed on seven days between June 17 and 25 with the Heliometer.

The Great Comet of 1882 was observed by Mr. Finlay, Chief Assistant, at 17^h on September 7. His observations of that morning appear to be the first accurate determination of the place of this remarkable body.

The Great Comet has been observed here since that date on every day on which it has been visible, and the following observations have been secured (till 1883, February 4, inclusive):—

With the Heliometer ...	...	31 observations
Equatorials ...	...	65 „
Transit Circle	...	17 „
Altazimuth ...	...	3 „

The comparison stars are under observation with the Transit Circle.

The unprecedented observation of the disappearance of this comet at the Sun's limb was made by two observers on September 17 (*Monthly Notices*, vol. xliii. No. 1).

Successful photographs of the comet were secured on six days. The last three of these show some details that could not be so distinctly seen with any telescope or opera-glass, and all stars down to 8 or $8\frac{1}{2}$ magnitude are shown. Paper copies have been forwarded to the Society.

A long series of drawings and measures of the nucleus have been secured.

Barnard's Comet has been observed with the Transit Circle S.P. on nine days.

7. The long series of Heliometer observations (referred to in last Report) undertaken for determining the annual parallax of the more remarkable Southern stars is nearly concluded, and the results will be ready for publication before the end of the current year.

8. The observations of *Victoria* and *Sappho*, for determining the solar parallax by Galle's method, were carried out in July, August, and September, according to the programme circulated by H.M. Astronomer at the Cape.

Victoria was observed on 54 nights.
Sappho „ „ 22 „

The following Reports have been received from Directors of Observatories who have kindly co-operated in the scheme :—

	Victoria.	Sappho.
Dr. Ball, Dunsink ...	12 nights	10 nights
Dr. Engelmann, Leipzig...	21 „	11 „
Prof. Bredichin, Moscow .	36 „	4 „
„ Krueger, Kiel ...	14 „	7 „
„ Schultz, Upsala ...	19 „	9 „
Dr. de Ball, Bothkamp ...	9*	

* This Report only extends to Sept. 3; the observations were being continued.

No Reports have yet been received from Paris, Strassburg, Potsdam, Clinton (U.S.), or Rio di Janeiro. A comparison between the observations of Gill and Elkin at the Cape with different telescopes, shows (if the observations of both observers are assumed equally good) that the probable error of one measure (eight bisections) is $\pm$ 0″·16.

Details of observations have as yet only been received from Dunsink, Leipzig, and Moscow. From these three Observatories, and for *Victoria* alone, there are sixty-four comparisons of $\Delta\,\delta$ in the Northern hemisphere, which correspond with a like number of separate comparisons at the Cape; or, if corresponding comparisons are not restricted to the same night, there are seventy-eight of such corresponding comparisons.

There is, therefore, reasonable ground to conclude that the

resulting value of the solar parallax from the whole of these observations will probably be at least as valuable as that derived from the Transit of *Venus* expeditions.

Victoria and *Sappho* have also been observed on the meridian—

Victoria on 37 nights.
Sappho on 18 „

The whole of the comparison stars (seventy-two for *Victoria* and sixty-six for *Sappho*) have also been observed on the meridian at least three times each; the more important stars much oftener.

The Heliometer observations of the "Scale-Value" and "Distortion-Stars" are not yet completed, but will be so in June and July of the current year.

9. The Observatory has co-operated to its utmost extent in the observations of the Transit of *Venus*. Mr. Finlay, Chief Assistant, and Mr. Pitt, Third Assistant, occupied a station at Aberdeen Road. Both contacts at ingress were observed by both these observers. The observations for time, latitude, and longitude at Aberdeen Road are reduced, and the results have been communicated to the British Transit of *Venus* Committee.

At this Observatory the internal contact at ingress was observed by six observers, and a number of Heliometer observations of the least and greatest distance of the centre of *Venus* and the Sun and of the diameter of *Venus* were obtained.

Programmes for longitude operations, and lists of time and azimuth stars were prepared for the Transit of *Venus* stations at Montague Road (British) and Wellington (American), and the necessary time observations were made, and signals exchanged with each on four nights.

Time signals were also sent to Natal, Grahamstown, and Port Elizabeth, before and after the Transit; as also to Natal, in conjunction with the operations connecting the longitude of Madagascar with this Observatory.

10. The longitude of Lady Donkin's Monument, Port Elizabeth, has been connected by telegraph with this Observatory, under the direction of H.M. Astronomer, but at the expense of the Government of the Cape Colony. The comparison of this longitude with the results of a trigonometrical connection of the same points, made by Captain Bailey, R.E., 1859–62, gives an arc of 7° 40′ of longitude (the latitudes of the extremities are nearly identical) possessing considerable geodetic interest.

11. *Instrumental Changes.*—A new 6-inch Equatorial by Grubb has been mounted, originally to observe the Transit of *Venus*, but by permission of the Committee it was fitted with micrometric appliances, and was partly employed in the observations of *Victoria* and *Sappho*. The instrument requires considerable alterations, however, to render it a complete or satisfactory instrument for other than star-gazing purposes. Optically it is an admirable instrument.

The old Wind Tower has been altered, a pillar built, and a

Dome erected to receive the 6-inch Equatorial. The whole forms a suitable and convenient Observatory.

The Government of India, on the representation of General Walker, has lent the great 3-foot Theodolite (constructed under the superintendence of Colonel Strange) to H.M. Astronomer for use at the Cape. This instrument has been employed in observing the Great Comet and the Transit of *Venus*, but will be chiefly devoted in future to determining the Declinations of Southern stars by observations of the azimuth of their greatest elongation.

Plans have been prepared for providing new collimators for the Transit Circle, and these so mounted as to permit the independent determination of the horizontal point to North and South, and observation of stars by reflection to 70° Z.D. The plans also include the erection of meridian marks to North and South, viewed by lenses of long focus. The plans are in the hands of Mr. Simms, and it is believed they will be completed about the middle of the current year.

12. The system of time signals has been further extended and improved; a clock controlled from the Observatory is also being erected at the entrance of the Cape Town Docks.

The tidal observations have been begun at East London; those at Table Bay will begin in March of the current year. The tide-gauges for Durban and Port Elizabeth have been received, but are not yet mounted.

The meteorological observations made at the Royal Observatory in the year 1881, together with those made in different parts of the colony, have been printed in the Reports of the Cape Meteorological Commission.

[The above Report arrived too late for insertion in the Annual Report of the Council.]

Errata.

Vol. xliii. p. 134, line 29 from top. *For* +0″·24, *read* −0″·24.
p. 142, line 22 from top. *For* LL. 1779·39, *read* LL. 1797·39.

Erratum in the Annual Report.

The six lines "He also . . . . Observatory," on pp. 159–60, are out of their place: they belong to the obituary notice of Mr. Walker, on pp. 183–4.